

The
AIRCRAFT
YEAR BOOK

For 1919



"THE AFTERNOON MAIL"

AIRCRAFT YEAR BOOK

ISSUED BY
MANUFACTURERS
AIRCRAFT
ASSOCIATION
INC.



1919

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PREFACE

THE manufacturers of aircraft have been participators in a great crusade. This crusade has had patriotic and scientific aspects. It has been attended by dramatic developments. A war-imposed secrecy has prevented aircraft makers from sharing with the public the drama of their effort. Now, however, the need for secrecy is past, and they can attempt a summing up of what they have done and experienced—a summing up which will be to a large extent a disclosure as well.

The Manufacturers Aircraft Association accordingly presents to the public its first Annual Year Book. This book is a story of the producers' part in the war. The facts for this record have been obtainable only through the co-operation and on the responsibility of each individual company. The Association cannot take credit nor assume authority for the data presented individually by its members, but it feels that by giving occasion for the appearance of this new information concerning the aeronautical industry, it has rendered the public a needed service. The Annual is also, in some measure a history of aviation, both industrial and scientific, a repository of aeronautical information and an interpretation of aeronautical fact for those who are unfamiliar with it.

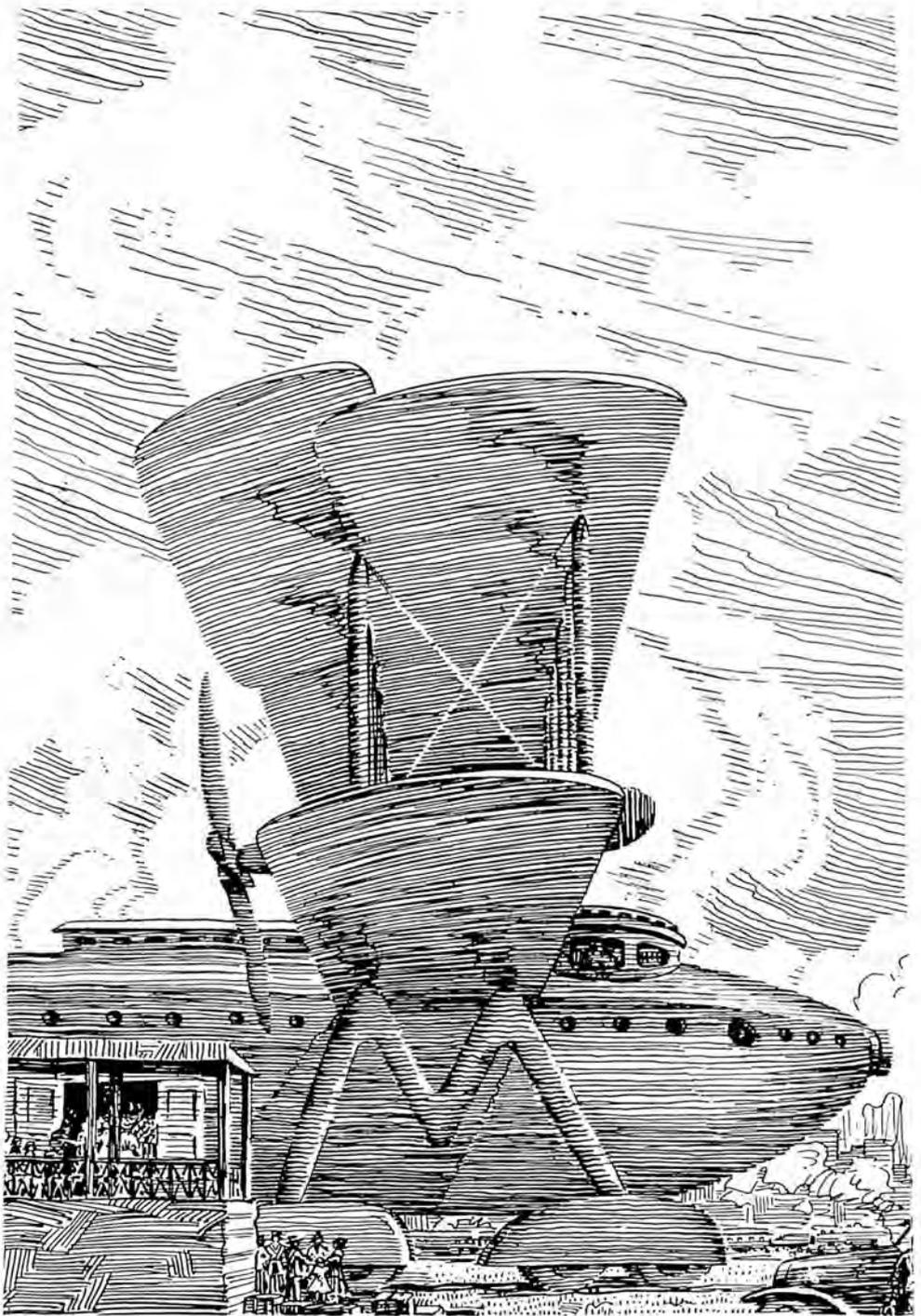
The Year Book, as a first effort, has deficiencies and crudities. It will, nevertheless, give the reader in picture and writing a record of the aircraft industry which he has never before possessed. It is hoped that journals, libraries, and individual readers will find this record valuable. It is believed that the American public will, through its pages, get a fuller understanding of aviation and a deeper conviction of its growing place in the national life.

MANUFACTURERS AIRCRAFT ASSOCIATION

FAY L. FAUROTE,

Editor, Year Book Committee

New York City, February, 1919

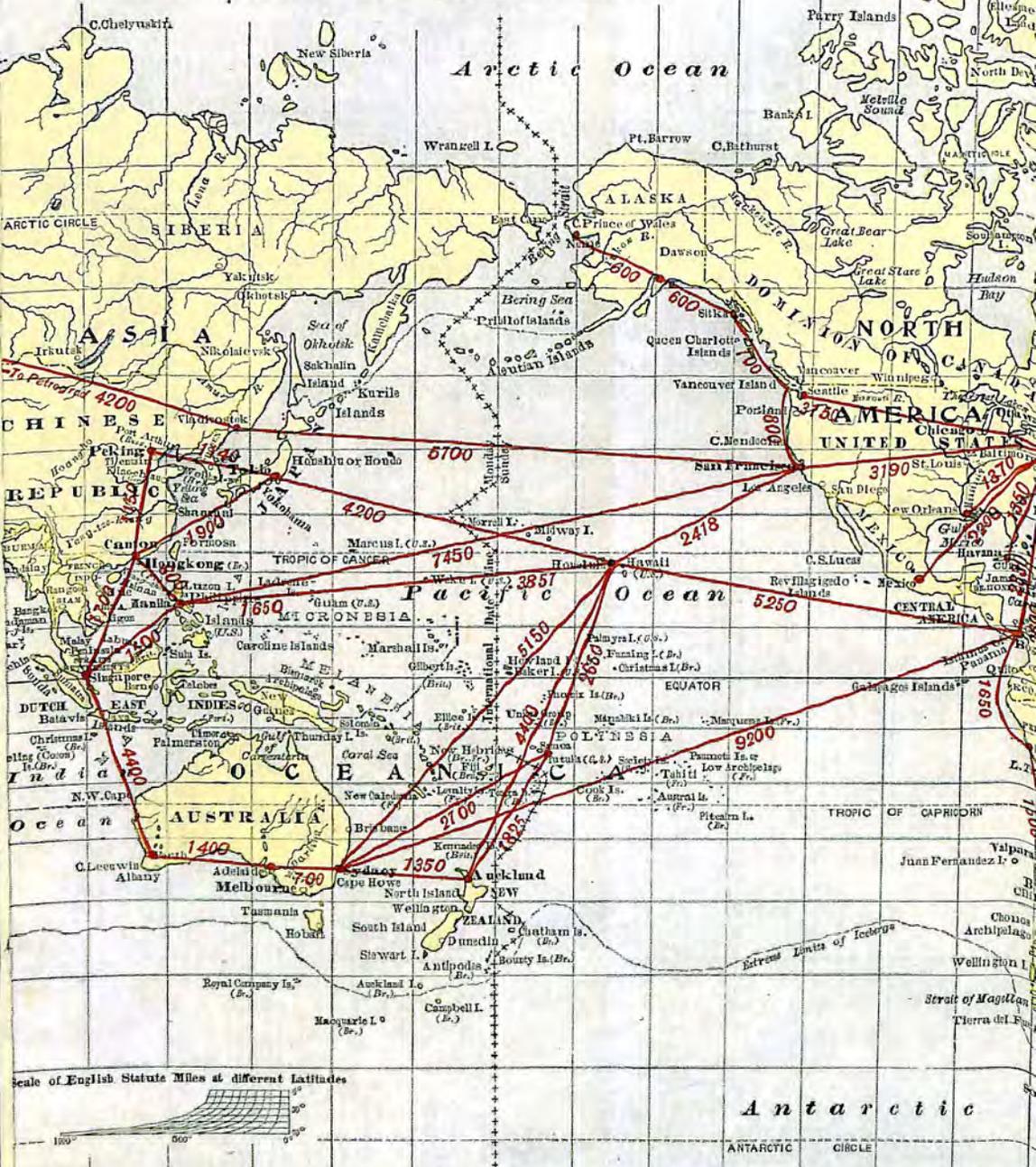
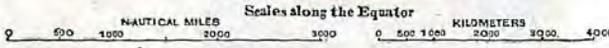


"THE NEW YORK AERIAL LIMITED"

Manufacturers Aircraft Association

MAP OF THE WORLD

Showing Aerial Distances between Principal Places
thus: — 3740 miles



Scale of English Statute Miles at different Latitudes



Antarctic

ANTARCTIC CIRCLE

THE FUTURE OF AVIATION

FREEDOM has become the most significant word of the day. This new sense of freedom and the science of aviation have come into the world's experience at the same time. The airplane itself is the material embodiment of freedom. Its streamline body and poised wings so suggest freedom that the most prosaic bystander is thrilled by the sense of it. There is freedom in the lift of the plane from the ground. There is indescribable and hitherto unknown freedom in flight, for the airplane subjects the air to its will and is freer than the air itself.

Of still greater significance than this physical manifestation of freedom is the fact that in the science of aviation, man has once more advanced toward scientific truth; by this science man has been freed from the old belief in his limitations, from the cramped power of one who is a creature of the earth and subject to it. Now, neither earth's mountains, nor deserts, nor storms are obstacles to his passage. Not only the world but the sky has been given to man's dominion.

TRUTH BORN OF DREAMS

It is an old story that the way of the world has ever been to regard those who made each new advance toward scientific truth as dreamers. The fact that Galileo stood the only man in all his world who knew that the earth was but a part of a greater universe, did not, in any degree, change the truth. Columbus was the only man of his world who glimpsed the truth that the earth is round and that man is not limited to a small part of it. He had the courage to put his faith to the test and the fact that no other man believed did not prevent his demonstration. The world was sceptical about the railroad, iron ships, the telegraph, the telephone and the automobile, but this scepticism did not keep these utilities from the world. The fact that men laughed at Langley, the Wright brothers and Curtiss because they thought that they could fly, did not keep these men on the ground.

It is true that men did not laugh at the inventors of the airplane as they laughed at Galileo or Columbus. They were not quite so sceptical as they were in regard to the railroads and the telegraph. The airplane came at the time when the world urgently needed it. The physical need was great and the mind of man was ready to accept it. So it came with liberty riding upon its wings.

Because of the war and the needs it created, the growth of the science and the art of aviation during the years of the war have been so far beyond belief that realization stands before the fact, hesitatingly accepted. It is at this time that science and art and business of flying are being compelled to take a stand against the prejudice that dared not present itself during the war, the same old prejudice that has tried in vain to check the progress of each new idea necessary to the advance of civilization.

ROMANCE TO REALITY

People are convinced that man can fly; they have seen him do it. They are not convinced generally that they themselves can fly or that their mail, their clothes and their food can fly. They take pride in the record aviation has made in the war; they thrill at the sight of a plane in a peaceful sky; but there are many who have difficulty in visualizing the commercial as well as the romantic and military possibilities of aircraft. It is a pleasant thing to watch the powerful flight of a distant plane. It is far more important that we should understand that the great white creature is a scout ship, sailing before the argosy which is making its way from the lands of romance to the world of our everyday experience.

The air is still throbbing with the glorious achievements of war craft. Nevertheless, the science of aviation is at the period of its greatest peril. It is at this time that men, who see far ahead and who have the courage to work and fight for what they see, are necessary for the future of aerial navigation and for the future commercial advance of the United States. Men of vision and men of power are needed.

WINNING THE AIR FOR AMERICA

The members of the Manufacturers Aircraft Association are looking ahead to greater achievements in times of peace for the airplane, than the wonderful achievements in time of war. They are looking forward to the day when American aircraft, of both land and water types, shall have made American ideas and American goods familiar and necessary to people in every part of the world. They foresee—and need not look so very far ahead of the rest of us—the time when the great burden of transportation shall be lifted from the crowded tracks of commerce to the free spaces of the air.

These men are certain of aerial mail and passenger and express routes connecting New York in a 40-hour schedule with Seattle and

San Francisco. They know that very soon the most inaccessible mining cabin and the most distant rancher's hut will be reached by the aerial mail. They realize now that world routes must be established and that supremacy on land or sea is not of so great importance as supremacy of the air.

Surely the power to demonstrate the truth of their vision is not lacking. Judge the certainty of the future in measuring past accomplishments. The manufacturers of American aircraft are well content to let past deeds indicate future possibilities.

MIRACLES AMERICAN MADE

According to figures given by Lieutenant H. H. Emmons, in 1917, the program laid down by the army and navy technical board called for more than 9,000 training planes and more than 20,000 combat planes. These 9,000 training planes and 16,000 of the combat planes were delivered and put into service before the armistice was signed. And upon the day of the signing of the armistice, there were 686 more planes at the port of embarkation than could be loaded.

None the less inspiring are the statements Lieutenant Emmons made in regard to the building of motors. The production of all engines during the month of October was 5,603, more than were produced in any one month during the war by England and France combined. By November 29, 1918, 15,600 Liberty motors had been delivered and engines of every type, notably Curtiss and American manufactured Hispana Suiza motors, totaled 32,000.

As for the production of lighter than air machines, more than 700 balloons had been delivered before the armistice was signed. On the authority of the facts America, the pioneer in aeronautics, claims supremacy of the air.

NO LESS THAN WAR

What has been done in time of war can be done in time of peace. The need is even greater now, for it is the need for all time and for all people, touching every part of the nation's development and the individual's need. John D. Ryan, former Director of Aircraft Production, has said, "I think that what has been accomplished in aircraft, in war times, will be duplicated to a great extent in peace times. I think the peace requirements will, in time, startle the world."

In his further discussion, Mr. Ryan touched upon the great present problem which the country is facing. Aerial navigation is in danger

of becoming, in peace, a lost art unless the people of the United States become conscious of the critical need of a definite constructive program combining the elements of national defense, science, and commerce.

JOHN D. RYAN'S WARNING

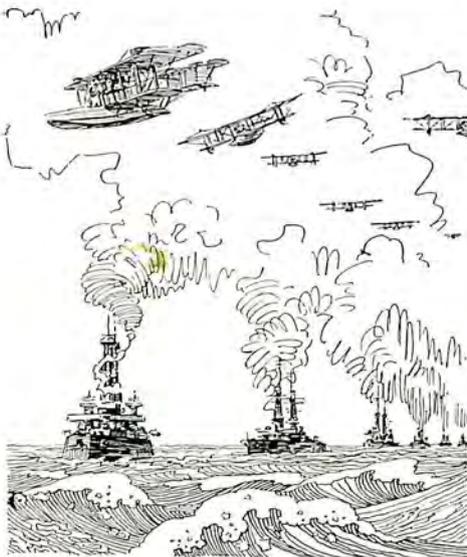
Mr. Ryan earnestly advocated the development of aircraft for coast defense. "I should think," he said, "that it would be plain to almost anybody that in the necessity for the defense of a great country like ours with a great coast line like ours, a very extensive aircraft program is a very desirable thing. I think the science of aviation should be encouraged in every possible way. I would have an academy of aviation just as we have a military academy at West Point and a Naval Academy at Annapolis.

"I think that within five years from now, an enemy fleet that attempted to reach the shores of the United States would be detected and located so far out at sea that it would be out of business 300 or 400 miles beyond the reach of the shore.

"I think it is a great pity that the brains in the aircraft organization should be scattered. I think that the great manufacturing organizations should not be destroyed or allowed to fall into disuse. I don't advocate the building of great numbers of aircraft for military purposes. I don't think it necessary. But I think that sufficient encouragement and employment can be given to the well-developed aircraft factories of this country to keep them in the aircraft business, to induce them to make every discovery, to do everything they can to promote the science of aircraft. The organization should be kept intact as far as possible. It would be a small expense and, God knows, it might be a great measure of economy some day."

WHAT OF THE PILOTS?

The question of the future of the air service with its 200,000 personnel is closely related to the question of support of the industry. It has cost between \$25,000 and \$30,000 to educate and train each pilot. There are about 17,000



such pilots. What is to be done with these men? The National Advisory Committee for Aeronautics has expressed the belief that federal legislation should be enacted and has suggested that representatives be appointed to confer with the committee to study the problem and recommend the general terms of legislation designed most effectively to encourage the development of aviation in the United States and at the same time provide for most effective military service.

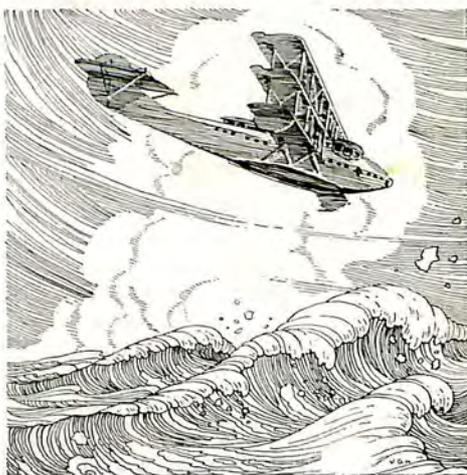
Senator Chamberlain, chairman of the Senate military affairs committee, has declared that development in aeronautics is absolutely essential.

"The control of the air," he says, "will unquestionably be the decisive factor in the next war." He declared that as much of the trouble we experienced in getting ready to fight Germany was due to lack of preparation, so failure to consider now in a constructive plan the whole aviation problem, military, naval, postal, commercial, will mean trouble in the future.

WHY DELAY IS DANGEROUS

Since other nations are making rapid progress in the science of aviation, delay and indifference here are inexcusable and dangerous. Detailed information as to far-sighted policy of Great Britain is contained in the report of the Civil Aerial Transport Committee on Aerial Navigation. This committee was appointed in May, 1917. At that time, the members foresaw the conditions which Americans are only beginning to realize to-day. The committee was divided into five sub-committees, and it was committee No. 3 which was asked to advise as to the development and organization of aircraft production from a commercial and financial point of view. In presenting their recommendations the special committee emphasized as an incontestable assumption that aerial power is as necessary for the protection of Great Britain and the existence of the Empire in the future as naval power has been in the past.

The committee reported itself, therefore, of the opinion that it would be necessary, after the war, to take such measures as would



maintain the power of production in this country with attendant power of design and progressive experiment. Without continuity it would be impossible to have the organization immediately available when required. The conclusions of the committee were:

AS BRITAIN SEES IT

“(a) The Committee are unable to foresee any such early development of aerial transport as could by itself keep the aircraft manufacturing industry alive.

“(b) It is essential that the service of the aircraft industry continue to be employed for the design and development of naval and military aircraft and for the carrying out of the national constructional requirements of the future. If that is done then no special steps would seem to be required in connection with civil aerial transport to establish the industry on a permanent peace basis.

“(c) Failing the employment of the aircraft industry for the purposes and to the full extent above indicated, then the industry could only be kept alive for civil aerial transport purposes by active Government assistance, not necessarily in the form of subsidies on manufacture, continued over several years to come.”

Further the committee stated that “it is of the first importance that the task of considering and of dealing with constructive proposals in regard to all aeronautical matter after the war should be definitely assigned without delay to some one government department, which would, of course, only act after consultation with such other government departments as might be concerned. It appears to the committee that such matters should be dealt with by a single central government authority, but that, to be effective for this purpose, the authority should work in conjunction with a body representing the industry.”

THE RACE FOR MASTERY

To-day it is said that Great Britain is going ahead with an aircraft program, inspired by this report, and predicated on the appropriation of \$100,000,000 a year for seven years. France is co-operating with its air service personnel in the maintenance of close relationship with regard to future aeronautical problems. The Italian leaders are well known in Washington, and it is generally understood that the Capronis and other aeronautical engineers are looking ahead in harmony with their government. Germany is reported to be “making secret preparations for the mastery of the air.” Meanwhile, Ameri-

cans everywhere, congressmen, aviators, manufacturers and the public are claiming, rightly and proudly, that America is first and greatest in the science of aviation and that it belongs to her by right of discovery.

As a matter of fact the industry will go on because it must. The world in its present state of development cannot get along without it. The fear has been expressed that the airplane is too deadly and that it must be kept out of existence. If an enemy, such as the last enemy to mankind, arises, no laws will have kept it from developing aircraft to its greatest power. The only thing we would have done would have been to have destroyed our only means of defense. There is every reason, instead, to look toward the great commercial future, which aircraft will make possible, and to the absolute protection which it promises.

COMMERCE ON WINGS

The second need of aeronautical development is one which is dependent on the manufacturers, designers and engineers. The planes already on hand must be modified in the best possible way to meet the demands of commerce. New types especially designed for commerce must be constructed. The immediate future of aviation requires the constant development of aeronautical engineering.

The whole problem of changing from military to peace construction is highly technical. Many of the present designs are of a purely military type and cannot be adapted to commercial uses where lifting power must be combined with speed and slow landing speed is essential. The weight distribution of a military plane is not suited for commerce and the fuselage is not strong enough. Sufficient room for the required load must be arranged and safety appliances for landings are needed.

PRACTICAL DEVELOPMENTS

A number of types of small planes will doubtless be in demand within a few years. The fast military combat plane can be used for no other purpose than that for which it was built, unless it might be adapted to suit the desires of sportsmen. A small plane, or flying boat, provided with a relatively small motor, great reliability and economy, good maneuvering qualities and very low landing speed, probably will come into general use, enabling the business man to live in the country by providing him with a swifter means of transportation than the train or automobile or boat.

Express planes will be needed to carry 2,000 pounds or more, and a demand is imminent for specially constructed passenger cars with

limousine bodies for greater comfort, multiple motors for greater reliability and speed, brakes and lowering of speed for landings.

Motors must last longer than those in the war craft. Vibration will be eliminated. Instruments must be arranged to meet adverse weather conditions. These things will be accomplished more or less quickly according to the encouragement given the industry. The first step, perhaps, is to apply different existing types to the work best suited to them, keeping accurate data as to the performance and results for future improvement.

Army and Navy aircraft, particularly the former, has been designed with a factor of safety subordinated to that of speed and maneuvering ability. While speed will, of course, play an important part in the development of commercial planes, the chief aim of manufacturers will be to build with safety and reliability of primary consideration.

Lighter-than-air machines are also being considered for immediate commercial development. Possibly the construction of the airship would not require so many changes for commercial adaptation as the airplane. The airship has greater carrying ability and is not dependent on its engine for lifting power. In rigid airships the proportion of available lift to total weight increases rapidly, and, therefore, airships of large size are more advantageous. At present, however, the heavier-than-air machines offer advantages in speed

and they are not so adversely affected by the winds. It is difficult to land an airship in a wind, but floating balloon sheds have been used with some success.



FLIES WITH FIFTY ABOARD

Probably one of the most interesting developments of aircraft to many people and certainly one of the most practical is the hydro-aeroplane and the flying boat. The most remarkable craft in America to-day is the Navy N. C. 1, a giant flying boat capable of carrying five tons, which has already made a flight with

fifty passengers and pilot. The advantages of a plane which can land on water are obvious, and it promises quick development along commercial lines because it does not make necessary the building of landing fields. Harbors, rivers, and small lakes make ideal landing places. The comparison between the speed of boats and railways gives the plane which competes with the boat a great advantage.

PROBLEM OF LANDING FIELDS

It is in the tremendously important question of landing fields that another problem of aviation arises. If man is to realize the great possibilities of flight, aerial travel must be made safe. There is no reason why it should not be the safest as well as the swiftest means of transportation. Aeronautical engineers are planning improvements that will make aircraft safer. No matter how perfectly constructed or piloted, an airplane cannot land in a city street, or in a back yard or in a forest without crashing. It would be a disturbing thing to a traffic policeman to have to stop the traffic all four ways at once while an airplane settled itself comfortably at his feet. It would be even more irritating to the housekeeper to have an airplane floundering about in the clothes on the line. The pilot, to say nothing of his passengers, would dislike the idea of landing in a treetop.

Landing fields are absolutely necessary—sufficiently large, open, well-drained landing fields and many of them. Regular transport for mails, passengers or express cannot be developed without landing fields close enough together to assure safe passage and regular terminals at which convenient connection with trolley or trucks, garages, telephone can be made.

PUBLIC IS AWAKENING

The development of landing fields depends upon the public. Indeed, the whole problem of aviation belongs there. Landing fields are, perhaps, the first necessity; through them the country can prove its readiness for aerial transport. As a matter of fact the impetus is already gaining headway. The interest and desire are awakened in all parts of the



country. Letters to chambers of commerce in various cities have brought immediate and enthusiastic replies, with inquiries as to the steps to be taken to get a place on the aerial map.

The first aerial maps of the United States have already been made. The War Department is engaged in making cross-country flights, mapping out air routes, and determining the most suitable ones. Seventy-three flights covering almost the entire country have been authorized and sixty flights flown. The flights from the Pacific to the Atlantic were made without difficulty and the return from Washington to the Pacific Coast has been begun. The total mileage covered in these flights is 44,058 miles. Data regarding landmarks and landing fields along these routes have been recorded and a complete survey of the facilities of the country in regard to available supplies and landing fields made.

One purpose of these flights is to demonstrate to the public the possibilities of the airplane in the future for commercial enterprise. The maps made by the officers on these flights are comprehensive and practical. With the use of such maps cross-country flying will be a simple thing, provided there were proper landing places.

One of the first maps published, that of the route from San Diego to Seattle, is of unusual interest because the route is above the mountains most of the way. There are towns in California 200 miles distant by railroad, but only 16 miles by air.

ROUTES BUT NO STATIONS

The pioneer aviators found the lack of suitable landing places the greatest source of danger. Katherine Stinson, in flying from Buffalo to Washington by way of New York and Philadelphia, had great difficulty in finding landing places at Rochester, Syracuse, Albany and Philadelphia. These cities are now among the first to express their willingness and desire for the establishment of fields. On the flight Ruth Law made from Chicago to New York, a stop was made at Erie. She had difficulty in landing there and similar trouble was experienced by Victor Carlstrom. Since that time Erie has been enthusiastic for the project of laying out a flying field, properly marked and charted on the aeronautical maps.

Glenn H. Curtiss, in preparing for his flight down the Hudson, made several trips up and down the river to find landing places. One spot chosen was near Poughkeepsie and of such importance has that spot become that a monument is to be erected there. It is, no doubt,

Manufacturers
Aircraft Association
MAP OF

EUROPE

Showing Aerial Distances
between Principal Places
thus:  750 miles

Capitals of Countries: 
Railroads:  Canals: 

Comparative Area.
PENN.
45,215 Square Miles.



worthy of a monument, but landing places are no less important to-day than they were ten years ago.

The importance of landing places to localities can hardly be estimated. As in railroad history the trains went where facilities were offered, the aerial routes, not restricted as to require smooth right-of-way will seek communities which offer the landing and flying fields essential to the safe operation of aircraft. One advantageous feature of the construction of landing fields is that the cost is very small as compared to the advantages obtained and as compared to railway terminals. The cost moreover, being dependent upon the real estate value is smaller for small towns, this fact regulating the cost so that any community can afford a landing field.

TWO KINDS OF FIELDS

Two kinds of fields have been suggested, the permanent and the emergency. The ideal field should be about a mile square, the smallest possible permanent field to be a twenty-acre tract clear of trees or other obstructions, one-eighth of a mile wide and one-fourth of a mile long—length in the direction of the prevailing winds. These fields must be well drained, sandy loam next to level sod being the best ground. The field should lie in the direction of the prevailing winds in the section where they are located so that the flyers may land into the wind.

These fields should be marked with letters or numbers at least 100 feet long, either white vegetable growth, crushed stone or lime being used. The fields should be as level as possible. Hangars should be maintained with telephone, gasoline and oil supplies available. Triangular flags of two colors flying from poles, would indicate the direction of the wind. Permanent fields might be established with little expense at fair grounds in hundreds of communities.

In addition to permanent fields there will be need for emergency fields at short intervals to take care of forced landings. Grazing land is desirable and crop land can be used. By the establishment of a chain of landing fields, the difficulties and dangers of a long flight are reduced to the difficulties and dangers of a short flight, which are almost negligible.

Foreign countries are taking up the question of landing fields with system and dispatch.

ITALY MAPS FIELDS

The landing fields are rectangular with level surface. Maps in four colors for each route are distributed to pilots, together with an album of the fields.

The Italian War Department plans to connect the cities of the Mediterranean Sea, Calabria with the southeast and southwest extremities of Sicily and these with the colonies of Libya and eventually with the African French and English colonies. When the program is completed a net of air routes corresponding to great communication lines will cover Italy up to the boundary line.

Italy plans, thus, not only to benefit by the communication between her regions separated by mountains and seas but to give opportunity to allied and friendly nations that they may profit by her geographical configuration "so located like a bridge extending on the Mediterranean till nearing the African coast and representing a natural terrestrial way between two continents."

Consider the dreams of Cæsar and of all the emperors of the once all powerful empire, with this simple statement concerning this "terrestrial way."

IN GERMANY

Germany had prepared for aerial navigation, for delivery of mail and for passenger travel before the war. This would have been a necessary part of her desired world supremacy. Aided by the imperial government the municipalities of Germany had laid out and established with recognized markings ninety-five landing fields suitable for airplanes and dirigibles of the Zeppelin and the Schutte-Lange type.

ENGLAND'S VISION

But it is England that has the vision into the future. Lord Montagu of Beaulieu has outlined a proposal for routes by which British aviators may be guided for flights of thousands of miles from England to the farthest points of the British Empire. He points out that there is a chain of British aeronautical landing places southward and eastward from Gibraltar about 900 miles from London flying toward Egypt, India and Australia. It is, indeed, a noble perspective, the whole world brought into closest touch, isolated hamlets reaching toward centers of civilization and from there reaching on across the seas to the skies of other continents.

FUTURE OF AERIAL WARFARE

As for the future of war craft, it is said that the power of the plane of to-day will compare to that of the future only as a motorcycle compares to the most powerful tank. A German Admiral remarked at the time of surrendering his ships: "You may throw them all into the scrap heap. The future lies with the submarine and the airplane."

Aerial craft of every description surpassed all expectations during the war. They were essential in every sort of action, in attack, in defense, in reconnaissance. Night and day, they were on guard, ready to carry swift destruction to the enemy, hovering with protecting wings over our lines. They demonstrated reliability, speed, control and strength. The enemy fortifications and formations and movements lay revealed beneath them, their night attacks were deadly, their carrying power and speed marvelous.

Great Britain has expressed its dependence upon the use of aircraft for coast defense. America is even more dependent. But in the future America's coast will be protected and defended by the use of aircraft of every sort. Aircraft equipped with wireless, patrolling the waters, will make advance upon the shores impossible. Communication between points along the coast will be constant and swift.

Airplanes have been used in detecting submarines, for it is possible from great heights to see into the depths of the ocean.

It is, however, to the great commercial future that the industry of aviation is looking, to aerial transport in times of peace between peaceful nations and on peaceful errands.

QUICKENING COMMUNICATION

Perhaps the first commercial need is that of the mail service. Less than a century ago, mail was carried by pony express, the same method that had been used all the ages before, and it took 36 hours to get the mail from New York to Washington. There is a regular airplane route between the two cities to-day and it takes three hours by schedule time. Trial flights for speed have been made in half that time. The regularity and success of this route proves that longer routes can be made practical when planes are modified to suit the business and when landing fields cut the long route into a succession of short routes, each one of which can be easily flown.

The New York to Chicago step will be the next one established, and for the successful service between these cities, five landing fields and emergency stops have been established. The routes worked out by the army will be of great service provided that cities along the route arrange proper facilities for landing.



The aerial mail will meet conditions that can never be met by railroad. At various places beneath its flight, mail could be dropped into large nets constructed for that purpose, dropped on the side of a mountain or in the midst of a desert, wherever the mail is wanted. Speed is important. In many cases a letter is preferable to telegraph or telephone communication, and it is not so costly and more reliable. At present, it is often necessary to use the telegraph or telephone. In the future the business man can transact his business with swiftness and economy by the aerial mail.

ISOLATION ISOLATED

It is not easy to appreciate all that the coming of the aerial mail will mean to places like Alaska. Details are constantly being improved upon by engineers. It is planned to have radio system block signal stations every twenty-five miles. These, of course, would provide a system of lights for night flying.

The longer the route, the greater advantage will be given by the aerial mail. The cost of a cable from London to Johannesburg is 8 pounds, 10 shillings for 100 words. The message takes 24 hours. The cost of a letter by airplane, it is estimated, would be two shillings six pence an ounce. The time of delivery would be six days. The present mail schedule is about 24 days.

The air mail from London would reach Calcutta in four days, as compared to sixteen days at present.

Aerial postal service has been proposed between Vancouver and Victoria and Vancouver and Nanaimo. Weekly service between London and India is planned and preliminaries have been worked out for a trial trip from London to Capetown. The British are not talking. They are working out their future system of aviation.

PULLMANS OF THE AIR

It is expected that within a month American passenger carrying aerial lines will be started. Plans are already under way for



the construction of a fleet of dirigibles for a New York to Chicago line, carrying a passenger list of twenty-five and a crew of ten. The plan is to have a company with four airships and two main terminals, one at New York and the other at Chicago. The ships are to be the Zeppelin type, rigid housing and multiple compartment. Helium gas is to be used, removing the danger of inflammability. Cabin accommodations will be in the interior of the housing structure, connected with a housed-in observation deck. The power plant is to consist of two engines. Arrangements will be made to have a lowering cage contained in the keel. Already the Navy dirigible C-1 has flown from Rockaway to Key West. Passengers have been carried from London to Paris. England, France and Germany are making extensive plans for aerial passenger service.

FLYING ACROSS ATLANTIC

It is in the consideration of the passenger service that the idea of Trans-Atlantic Flight becomes most persistent. Navy aviators are predicting that the flight will be made within a few months. American manufacturers believe that the flight can be made successfully, and from the other side persistent reports come that the flight is about to be attempted. It is said that the British Air Ministry will be ready to attempt the flight by June, 1919. Perhaps even before that time the flight will belong to American history.

Across the Atlantic or not, it is certain that very soon the business man will be able to get to Chicago in eight or nine hours and the traveler will be able to realize a new experience.

TRAVELERS OF THE SKIES

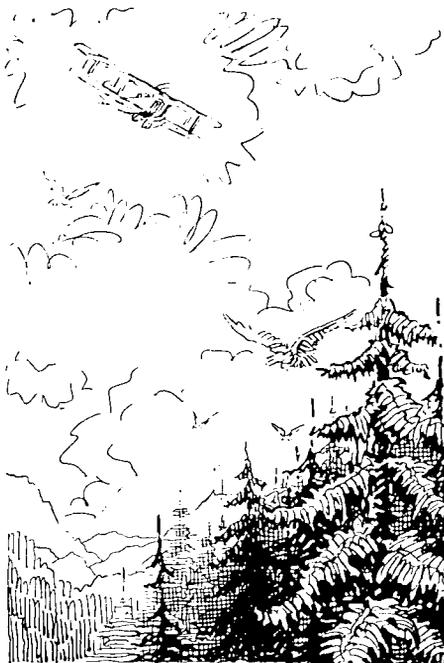
It is not a difficult thing to visualize that flight. You will sit in a comfortable limousine-bodied car, traveling at high speed without the slightest sense of jolt or vibration. You flash through sunshine or whirl through storm with never-failing power. You are no part of the earth upon which you can look with the most detached and critical sense of superiority. You are not shunted and shuffled about



in railway sheds; you are not annoyed by the dirt or noise. You glide down from the sky into a meadow, long enough to wonder at the familiarity of the earth and then you take to the air again. You arrive at your destination hours sooner than has ever before been possible. A nice enough picture and absolutely certain of realization.

Transportation means never have been adequate and they are less satisfactory each year. The problems of distribution have been the great factor in the high cost of living. There are, therefore, great opportunities in the carrying of light freight and express by airplane and of heavier freight by airship. To be sure the question of cost is as yet undetermined, but it is evident that by relieving congestion and stabilizing prices, the benefits would be great.

In many ways aircraft has a great advantage. There are no costly tracks to be maintained and the necessary terminals are less expensive. The number of people necessary to the operation of the system is much less in the case of aircraft than in the case of railway. In instances where great speed is to be desired the cost is not so much to be considered. In countries where the construction of railroads is impossible, or extremely difficult, the advantages of aerial transport are, of course, incontestable. Loads carried by aircraft are comparatively smaller, but more frequent trips can be made.



AERIAL MINING NEXT

It is not sufficient to compare transportation by aircraft with that by ancient carts or slowly moving sailing vessels or even with the railroads and motor car of to-day. The airplane should, in all justice, be compared to the caravan that still moves across the desert, the sledge that is drawn by dogs across the Alaskan or Siberian wastes, the pack mule that makes its way on stubborn mountain trails. Compare these toilsome means of carrying things most precious to the world to the swift and easy passage of the airplane.

Miners, everywhere, are begin-

ning to consider the practical means of employing airplanes to carry the workers to and from isolated pits and to transport the metals to market.

An internationally famous mining corporation is considering the use of airplanes in taking gold bullion from Mexican mines. Owners of oil wells in Wyoming and Texas are inquiring concerning the feasibility of using airplanes to establish and inspect fields. The patrol of high-power lines through rough and unsettled country is another use to which aircraft has been put.

PATROLLING THE FORESTS

The advantages of aircraft for coast defense have already been mentioned. They would be none the less useful in guarding forest against fires, or making smuggling on the Canadian and Mexican borders impossible.

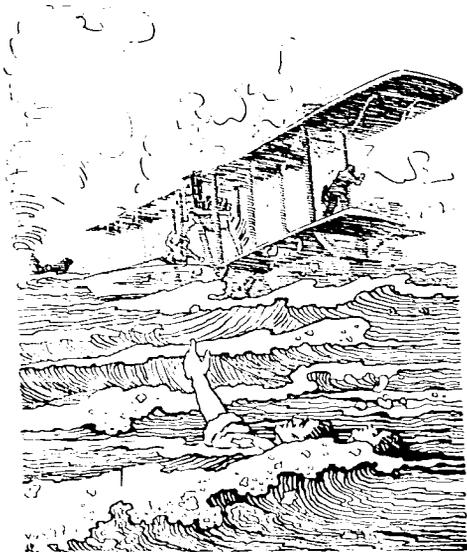
An officer who was stationed in Texas says that it is extremely difficult to locate stolen groups of cattle on a Mexican landscape, but airplanes have already been used successfully in finding bandits and stolen property.

The service that airplanes can do in watching vast forests will mean millions of dollars and many lives saved from fire each year. Wrecks, conflagrations and every sort of catastrophe can be reported by airplane, fitted with wireless, and losses thus minimized.

It is planned that New York Harbor shall be policed by aircraft. San Diego, California, now has its aerial fire boat.

SPYING EARTH'S SECRETS

Aviation offers a great impetus to exploration. Man has done almost as much as he could do with the means at hand. There is, probably, no place in the world where he cannot fly. No doubt countries which have never been fully explored will be brought into close view. Moving pictures of these places will be taken and the world be made familiar with them. The development of South American commerce offers a rich field to American business interests.



Both practical and theoretical meteorology have already received new impetus through the demands brought about by the increase in aviation. The study of the science is being taken up thoroughly and will result in benefits to the whole world as well as to those men immediately concerned with flight. The first aerial weather forecast to be issued in the United States was made public in December, 1918.

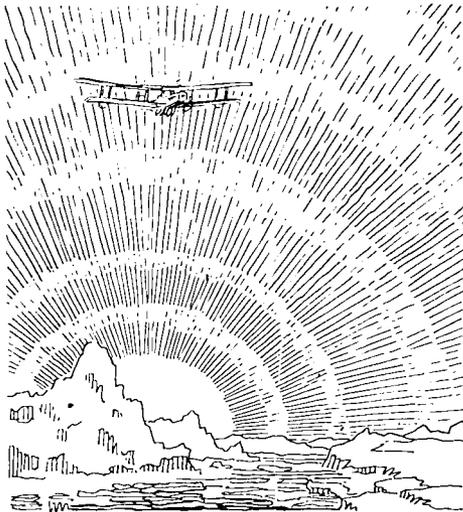
The airplane is not to be used as a public benefactor alone. The opportunities for the enjoyment and benefit of the individual are no less certain. The airplane and the flying boat offer the most exciting and satisfactory sort of vehicle for sport, including racing, display of skill and hunting.

HONEYMOON IN THE CLOUDS

Although the airplane probably will appeal almost immediately to sportsmen, particularly to those aviators that have already made the old world gasp at their daring, the prosaic business man will not be long in making use of aircraft for his convenience and for the enjoyment of his family. A "honeymoon" special has been constructed which is warranted to give service long after the honeymoon.

The business man can reach his office without hurrying for a train, without standing in a street car, without suffering the annoyances of a subway. When the day is done, countless small planes will wing their way in every direction, each one seeking its own little back home landing field, where it can fold its wings and creep into the hangar.

NEW LAWS OF THE AIR



Even after types and landing grounds are perfected, there remains the great question of national and international laws regarding the regulation of flying. These have been taken up at length by Great Britain and an act to regulate the use of aircraft has been introduced in Parliament. The act deals with the licensing of pilots, the inspection and registration of planes and the rights of way. So thoroughly are the details discussed that the reader is apt to get the

impression that the sky is already crowded with aircraft and the traffic in a terrible state.

In a discussion of the world air routes and their regulation, Lord Montagu gives the suggestion that five levels should be used. The first 2,000 feet, he thinks, should be free except for private purposes or purposes of landing. The next 2,000 for slower commercial planes and the levels from 4,000 to 6,000 for swifter commercial planes. Above 6,000 feet should be reserved for official planes and heights above 10,000 should be international. Lord Montagu thinks that all planes flying below 8,000 feet should be silenced.

It may seem that with international flying above 10,000 feet high, we have gone almost far enough. It may seem very foolish to attempt to look beyond. It is impossible not to look around.



FRANK H. RUSSELL
President Manufacturers Aircraft Association

THE MANUFACTURERS AIRCRAFT ASSOCIATION, INC.

General Executive Offices

501 FIFTH AVENUE, NEW YORK CITY

AEROMARINE PLANE AND MOTOR CORPORATION	1881 Broadway, New York City
THE BURGESS COMPANY	Marblehead, Mass.
CURTISS AEROPLANE AND MOTOR CORPORATION	New York City
DAYTON WRIGHT AIRPLANE COMPANY	Dayton, Ohio
THE ENGEL AIRCRAFT CORPORATION	Niles, Ohio
FISHER BODY CORPORATION	Detroit, Mich.
THE GLENN L. MARTIN COMPANY	Cleveland, Ohio
L. W. F. ENGINEERING COMPANY	College Point, L. I.
STANDARD AERO CORPORATION	Plainfield, N. J.
STANDARD AIRCRAFT CORPORATION	Elizabeth, N. J.
STURTEVANT AEROPLANE COMPANY	Jamaica Plain, Boston, Mass.
SPRINGFIELD AIRCRAFT CORPORATION	Springfield, Mass.
ST. LOUIS AIRCRAFT CORPORATION	St. Louis, Mo.
THOMAS-MORSE AIRCRAFT CORPORATION	Ithaca, N.Y.
WRIGHT-MARTIN AIRCRAFT CORPORATION	New Brunswick, N. J.

"Where there is no vision, the people perish."—PROVERBS.

WHEN progress changes the forms of human institutions and forces conditions which to the unawakened world seem unwise and premature, men can only wait on God and see his wondrous works unfold. Nor can men, in such times of stress, dictate actions to their selfish ends. Only as the spirit of co-operation and fair play rules, can they hope to secure profits or products worthy of their ideals.

Through such a critical time the civilized world has just passed, and by such a willing co-operation in industry, art and science, has it achieved a victory—alike priceless and secure.

The American people and their allies rejoice in a wider freedom, a social union and a promise of industrial prosperity such as the world has never experienced.

To aviation, more than to any one other industry, may this desirable result be attributed. The airplane is a new agency, a new and useful tool, terrible and menacing on the battlefield of war, but none the less useful and progressively necessary on the peaceful highways of commerce. Indeed the airplane may be regarded as

one of the most compellingly civilizing influences in the world to-day. By it the limitations of both time and space are being reduced and what were the "uttermost parts of the earth" brought to one's doorstep, so to speak.

Looking back over the last fifteen years it seems hard to realize that the aeroplane has not always existed, so common and necessary has it become. Behind it, however, lies an industrial history replete with personal and organizational efforts, splendid testimonials of the ability of men to work together harmoniously and patriotically for the establishment of a world-wide democracy.

The Manufacturers Aircraft Association stands as a splendid industrial achievement of this kind.

Previous to the great war, the airplane had been regarded as the plaything of the wealthy, the freakish toy of the exhibitor, a dangerous and uncertain contraption, never as a vehicle necessary and advantageous to commerce.

Various attempts had been made to popularize it. Two aeroplane shows had been held. The Aero Clubs and their affiliated organizations throughout the world had done their best to convince people of its utilitarian value, but only slow progress was made. New inventions are never accepted at first. Popular prejudice must be broken down. The worth and place of the new invention is always begrudgingly acknowledged.

Several attempts had been made on the part of the aircraft manufacturers to get together, but patent litigation, personal jealousies, and a lack of an appreciation of the true value of co-operation had made the welding process a slow one.

Finally, however, in February, 1917, during the Aeroplane Show in New York City, Harry Bowers Mingle, the president of the Standard Aircraft Corporation, sent out letters inviting the various aeroplane companies to send representatives to form a committee to discuss the situation. His invitations were accepted. The committee met and the Aircraft Manufacturers' Association was formed on February 13, 1917. Most of the important aircraft manufacturers joined.

In this organization, however, there was no attempt made to solve the patent situation. Meetings were devoted almost entirely to the discussion of technical and business problems affecting the industry at that time. Only a friendly co-operation between the members was sought. The efforts of the association were directed almost entirely toward improvements on the airplane and much

was done to educate the general public as to the airplane's real value and future.

In the meantime, in the battlefields of Europe, the airplane was rapidly making a place for itself. It had proved to be of such strategical value that its wider use was recommended, and England and France had already begun to approach American aircraft manufacturers with large orders for both land and water machines.

From an infant industry, struggling for its very existence, the aircraft business quickly grew to a size which caused the eyes of the world to be focussed upon it.

Immediately upon the entrance of the United States in the great war in April, 1917, the Army and Navy Joint Technical Advisory Board, basing their estimate upon an army of one million men which the War Department expected to place in the field, recommended the immediate manufacture of 3,000 airplanes. They called upon the Manufacturers' Association for help in this emergency. Following this invitation, a number of meetings of the Association were held in Washington, and the Government officials were advised that the aircraft factories then engaged in the work had ample capacity to supply the number without further expansion.

Hardly had this decision been made, however, when the English and French missions arrived and went into conference with the American Board.

It was soon found that European conditions were such that not 3,000 airplanes were needed, but 20,000. England at this time was losing about as many planes per month as she could manufacture. France needed planes badly and so did Italy and Belgium. Therefore, the Government officials cast about for an additional supply. A survey which had been made by the National Council of Defense showed that the motor car industry was in splendid condition to handle much of this additional work, particularly that required for the building of motors.

The automobile manufacturers, however, were not acquainted with aircraft production methods, inspection or design. They looked askance at the aircraft patent situation; they knew that there were a number of unsettled suits pending, and their acquaintanceship with patent litigation in connection with the Selden automobile patent had naturally made them cautious about accepting any contracts which might involve them in future litigation or result in cancellations or delays.

The members of the Aircraft Production Board realized the seri-



PROF. JOSEPH S. AMES

ousness of this situation. A Government committee was appointed to study the patent problem and suggest a means whereby the automobile and other manufacturers, upon whom they were going to depend for increased aircraft production, might be allowed to use the aircraft patents without infringement, hindrance or delay.

The Aircraft Manufacturers Association was, therefore, again called into consultation, and a committee composed of Messrs. Russell, Flint, Houston, Tarbox, Neave and Crisp was appointed to draw up a cross-license agreement, under which all manufacturers to the Government might have unrestrained use of all airplane patents and be free to fulfill the Government contracts in full accordance with specifications. This committee worked for two weeks and finally submitted to the Patent Committee a Cross-License Agreement very similar to that under which automobile constructors have been working for some time.

This Cross-License Agreement was approved of by the committee, and the rate of royalty to be charged, which was considerably lower than that of corresponding automobile patents, approved as reasonable and just.

In accordance with the wishes of the Government officials, all manufacturers engaged in Government airplane construction were invited to become members of the Manufacturers Aircraft Association and work under its Cross-License Agreement by which all patents, not only basic, but others of a more recent or minor character, were made available for use by all members. Not only this, but offers were made to supply designs and sample planes to these manufacturers to whom the Government had recently given aircraft work.

The members of the Manufacturers Aircraft Association were also asked to give such assistance as they could to prepare such motor car factories for aircraft production. Furthermore, it was arranged that if any special model was patented by one company, and was desired by another, the company holding the designs would furnish full plans and specifications on the agreement of the other to pay the stipulated fee as given in the Cross-License Agreement.

The Association would then pay the company holding the designs the money which the user of the design had paid to it for the privilege of use.

In case patents were acquired by members of the Association



W. BENTON CRISP

after the signing of the agreement, a board of arbitrators, appointed by the patentee and the corporation, was to be appointed to decide upon the value of the patent. All disputes between members were to be settled in a similar manner.

Any reputable constructor engaged in Government aircraft work could become a member of the Association on the payment of the entrance fee and would then have full access to all patents under terms of the agreement.

Thus, in order to handle the business of the Cross-Licensing Agreement satisfactorily, the Manufacturers Aircraft Association was organized July 24, 1917. Needless to say, it had other purposes as well. It carried on all the work of the Aircraft Manufacturers Association with respect to unification of the air industry, the education of the public on aircraft matters, etc. But the technical cause for its birth was the satisfactory operation of the agreement, and its nature was somewhat determined by this fact. The Cross-License Agreement was accompanied by a Voting Trust Agreement. By the terms of this instrument the control of the corporation was placed in the hands of three voting trustees for a period of five years. These trustees, it was felt, would assure all stockholders of an impartial and efficient administration of the organization. W. Benton Crisp, Professor Joseph F. Ames and Mr. Albert H. Flint were chosen. All were well known. Mr. Crisp, whose interest in the corporation had developed from his work on the Patent Subcommittee of the National Advisory Committee on Aeronautics, had served as Henry Ford's attorney in the Selden Automobile Patent case, and as representative of the Hudson interests in the Hudson Crank Shaft case. He was to act for the Corporation as general counsel, as well as trustee. Professor Ames was a well-known physicist. As Professor of Physics at Johns Hopkins University he had attained an international scientific reputation. He had been sent abroad by President Wilson as a member of a committee to investigate European scientific conditions. Serving on the National Advisory Committee on Aeronautics, he was well informed concerning the Government's policy and, it was felt, would stand aloof from any influence tending toward partiality. Mr. Flint had been prominent as a railroad executive before he became connected with the L. W. F. Engineering Corporation. Mr. Crisp represented the Wright-Martin and Curtiss interests, Mr. Flint those of the other corporation members, and Professor Ames, chosen by them as a third member, was entirely neutral.



Officers and Representatives of the Manufacturers Aircraft Association at a meeting at the Standard Plant

The charter members of the Manufacturers Aircraft Association were:

Aeromarine Plane and Motor Company.
The Burgess Company.
Curtiss Aeroplane and Motor Corporation.
L. W. F. Engineering Company.
Standard Aircraft Corporation.
Sturtevant Aeroplane Company.
Thomas-Morse Aircraft Corporation.
Wright-Martin Aircraft Corporation.

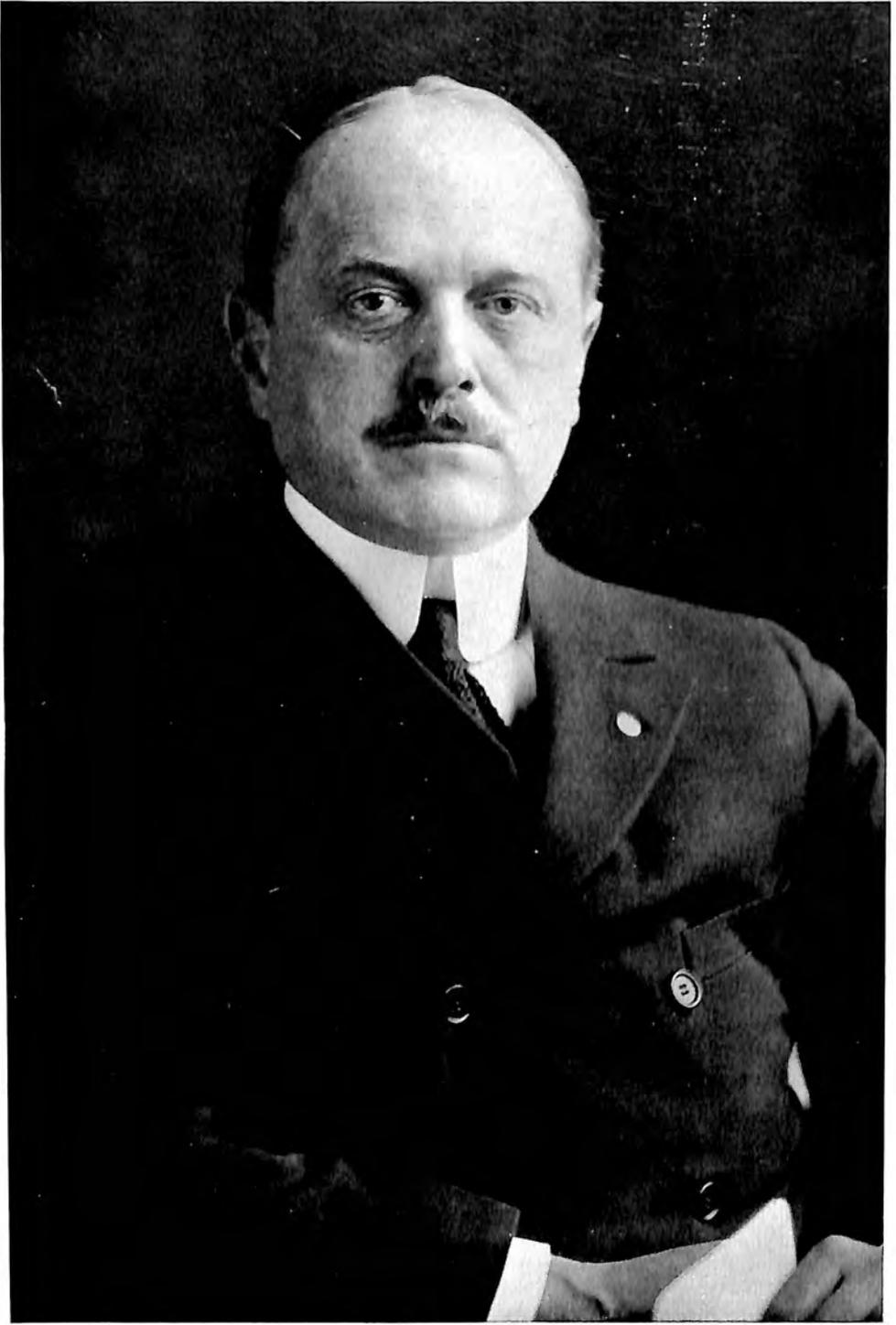
A few months later the following concerns became members:

Dayton Wright Airplane Company.
Fisher Body Corporation.
Wright-Martin Aircraft Company of California (formerly the Glenn L. Martin Company).

The original officers were: Frank H. Russell, President; Albert H. Flint, Vice-President; Benjamin S. Foss, Secretary; H. B. Mingle, Treasurer; Mr. Benjamin L. Williams, Assistant Secretary.

It may be said to the credit of these members of the committee who drew up the Cross-License Agreement that the Association has functioned perfectly ever since its organization. It has, on five different occasions, been investigated, first by the Attorney General of the United States to determine its legality and to make sure that it was not a trust, a combination operating in restraint of trade; secondly, by a special patent committee appointed by the Signal Corps of the Army, which was asked to pass upon the validity of the patents and their worth; thirdly, by a committee of the U. S. Senate; fourthly, by H. Snowden Marshall, and finally by Charles E. Hughes, who conducted an exhaustive investigation of the entire industry at the direction of the President.

It was clearly shown in all of these investigations that the Manufacturers Aircraft Association, Inc., had been a beneficial organization in every way both to the Government and to its individual members. It had prevented patent litigation, enabled the Government to deal with a single body of men in a harmonious and efficient manner, educated the public on the progress of aeronautics, assisted the technical and production boards in the securing of rapid and good production and allowed the aircraft industry to develop and expand quickly, naturally, and along the lines laid down by the War and Navy departments.



SAMUEL S. BRADLEY

A total of 13,943 planes have been manufactured under the Cross-Licensing agreement. From July 1, 1917, to December 31, 1918, the number increased for each three month period from 462 to 4,194.

The whole arrangement resulted in great economy to the Government because, in view of the greatly increased production and the consequent expense chargeable to aircraft appropriation, the Association reduced the royalty fees due the holders of the patents during the war by one-half. This economy was put into effect immediately and acknowledged by the Secretary of the Navy on March 28, 1918. This proposal was concurred in by the Secretary of War and submitted to the owners of the patents and manufacturers who accepted it by signing a supplemental Cross-License Agreement under date of April 19, 1918.

These and many other desirable ends were attained by the Manufacturers Aircraft Association through its efficient General Manager, Samuel S. Bradley, who was appointed during August, 1917. The Association kept in close contact with all the Governmental departments in Washington, and held itself ready at all times to aid in the carrying on of the war. It and its members furnished much of the data and material for the Army and Navy's aviation schools—flyers for instructors, specifications, plans and models for new manufacturers and contributed much to the art and science of aviation. It has promoted the establishment of landing fields throughout the United States, it has pointed out the importance of the airplane as an agent of natural defense and of commercial propriety. It has recommended designs and plans of an advanced nature and has in every way endeavored to do its bit in an unselfish and patriotic manner.

The Association has co-operated with the Post Office Department in the establishment and maintenance of mail routes, in the mapping of new country, in photographic work, forest survey, meteorological observation and in many other ways.

As this article goes to press, the Association is engaged in the promotion of an Aeronautical Exposition in which Army, Navy and Civilian Aircraft will be exhibited and much material which, due to military censorship, has remained secret during the war, will be shown for the first time.



ALBERT H. FLINT

THE BANQUET

THE banquet of the Manufacturers Aircraft Association was held at the Waldorf-Astoria, New York, on January 7th. Mr. Frank H. Russell, the toastmaster, in his opening remarks, reviewed the occasion when the Aircraft Manufacturers Association, then two months old, was invited to Washington by the Advisory Board for Aeronautics to consider the question of preparation for the war which at that time seemed inevitable.

"The discussion there," said Mr. Russell. "was how many airplanes were going to be needed. Somebody thought we would have an army of a million men, and there ought to be at least an airplane for every thousand men, so that meant a thousand airplanes, and then possibly two in reserve, so if half a dozen companies could make 3,000 aeroplanes, we would have done our duty, and done it well. We had about 5,500 men at that time building in various parts of the country.

"But, with the arrival of the British Mission, and a thorough realization of what the problem of fighting in the air meant, the demand grew from 3,000 aeroplanes to 25,000 aeroplanes, and our work began. At first we were a bit lonely, but automobile manufacturers throughout the country came to our aid and as they came, if they were building aeroplanes, they were welcomed into our association, and for well nigh two years we worked together.

"Our forces grew from a paltry 5,500 men to the time of the armistice, 175,000 men and women. Were those men and women working industriously? The fall of 1918 found the country supplied with more motors and more aeroplanes than could be conveyed. But our work for aeronautics has really only begun. So instead of a victory dinner we are here to-night as a council of peace for progress.

"We have a number of regrets. Among them are those from the Secretary of War, from the Secretary of the Navy, from Dr. Charles Wolcott of the Smithsonian Institution, from General George O. Squier, from Colonel Sidney Waldron and from Orville Wright.

"We have a very pleasant surprise, Colonel Bishop, a man who is already very well known throughout this country. In 1915 Colonel Bishop was a boy in Toronto, Ontario; he joined the Artillery, went into service, went from there to become an observation officer in the aircraft service, was brought down, went back and nobody heard of him for five or six weeks, but when he reported for duty he was a full fledged aviator. In a matter of three months he had cap-

tered the military medal, and the military cross. With a record of 75 machines brought down officially, and 23 more reported, he is the All-American Ace."

Colonel Bishop, speaking of the future of aviation, found promise of great developments in the wonderful history aviation has had during the last four years.

"I feel convinced," said Colonel Bishop, "and really I have seen airplanes do some extraordinary things—I feel absolutely convinced that the future of aviation is not in warfare. It is in commerce, and I think that the wonderful record the science of flying has had will be equalled and surpassed in the next few years by the development of commercial aviation. The first startling thing will be the trans-Atlantic flight and, as every man here knows, that is not far off—not for one machine, but for many machines. At the end of another year, I feel quite confident that scores of machines will have crossed the Atlantic. And a great number of men here tonight will doubtless take that trip.

"This trip will, without doubt, be done not only in the big machines, but in the small machines. Both of these types have their advantages for commerce. The general idea among the outside public seemed sometimes to be that the only machine fit for a commercial purpose is the big, many-engined machine. This machine undoubtedly has tremendous advantages in carrying weight, in going long distances, and by reason of its two, three or four motor engines, it may be more reliable, but the engines which have been turned out of late in your country, in England and France and Italy, have shown us that single engine machines may now be reckoned upon to be absolutely reliable, and that a person flying a machine with one engine, one of the good ones, may rely on that engine not to let him down.

"This is undoubtedly the biggest step that flying has taken, because in the past the people were very frightened of flying over bad country, continually worrying—I have done it myself—of landing in corn fields, woods and all sorts of things. Now, with engines that one can rely on, we feel absolutely confident that it will carry you through. The little machine will be cheaper in every way; will, of course, not bring the same results with the one exception of speed, and it will always be the fast machine.

"I think that it is an extreme case, but you might compare the big machine as you would compare an ordinary roadster to a bus, and I believe I would certainly take the ordinary machine if I were

going on a long trip from here to Chicago, preferring the roadster to the bus. The Atlantic will certainly be flown in the course of the next six months by more than one machine of the two, three and four passenger class."

The toastmaster next introduced the Rev. Nehemiah Boynton as a man who gave to the service of the country his three sons, and not stopping at that, gave his son-in-law, two as Chaplains, one as a lieutenant in the navy, the other in the air service, and then he himself served for a year on this side. Mr. Boynton referred to the new spirit that has come into the world through the war, a spirit that is linking two great names and both Americans—Lincoln and Washington. A principle of friendship, he said, has been set up in the world. He found it in business no less than among soldiers. "They are finding," he observed, "that it is not worth the time of a decent all-around man to be just piling up dollars." Service was needed.

"I congratulate you, gentlemen," Mr. Boynton said, "that you, with these young men, who have made use of the products of your skill so efficiently over the sea, are gathered together tonight to secure the permanence and the advance of the craft which you are introducing, and I only ask this of you, that, as I know you will, you put yourselves on the same level with all the other merchants and manufacturers of our country who are asking themselves, as never before, the more serious question as to what, after all, it really means to be in any business which is worth while, and who judge the efficiency and worth-whileness of their business, whatever it may be, by the manner in which it can be made to minister to this growing ideal of a friendship of the world, which is being built today upon the sacrifices of those who have offered their lives for righteousness and for justice, and beyond that, on the earnest efforts of those who are living not first of all for themselves, but first of all for their country and the welfare of the world."

"About a year ago," the toastmaster said, "the President appointed a committee to investigate the aircraft situation, and that committee was headed by H. Snowden Marshall. "Our anxieties ceased, then," he added, "for we knew that we would get a square deal. It is a very great pleasure to-night to have Mr. Marshall with us."

Mr. Marshall, opening his address, reminded his hearers that on the 11th day of last November the production of aircraft in this country had gotten under full swing. The whole force of the country

had gotten back of it; it was approaching—although it had not yet reached the very top of the speed that it was approximating.

“I am told,” Mr. Marshall went on, “that on that day there were aircraft in this country that could not be shipped abroad for lack of ships. On that day, in the foot-race that was going on between Mr. Ryan and Mr. Schwab, Mr. Ryan had forged ahead almost a lap. Now, because that success had been reached, because everything had gone so well, and because this country was taking a great pride in its manufacturers of aircraft, I think perhaps you will be glad to have me dig up the dry bones of the past and tell you how bad it was, or was thought to be, not quite one year ago.

“Last March, I would say, was the time when the blackguarding of aircraft manufacturers reached its zenith. Every editor who had anything to spatter, spattered you. Every fellow who wanted cheap notoriety abused you. The most remarkable men, from the most remarkable sources appeared in public places, posing as experts in aircraft manufacture and chucked bricks at you.

“Well, the first thing I walked into was a fight. There was the most tremendous lot of vituperation going on, the most blasphemous charges of fraud, of treason, of profiteering; there was a sort of a general impression on the part of some newspaper men at least that every factory for aircraft was infested with German spies which tore down the work as fast as it was put up. It is now happily forgotten, but that was the state of the public mind at that time.

“I think I will be violating no confidence at all if I say that every member of our committee, after going up and down and all over the country and looking at all of the people and discussing things with the manufacturers, and with the Signal Corps, and with everybody concerned, unanimously formed the opinion that there was no truth whatever in the false and libelous charges that had been made against the body of the people who were working on this, but that we had been in contact with an able, a patriotic, and an honest body of men who were striving, under the great handicaps to accomplish a great good for their country.

“Now, I have been asked here, of course, to talk of the past, but I can't help thinking of the future. The problem we have here now is a pretty big one—it isn't as big as the one we had before, and as we solved the last one, I am sure we will be able to solve this one, but here we have aircraft turned out in quantity, talented, skillful manufacturers able to turn aircraft out.

“It is a certainty, as sure as people can be of anything that they

don't know, that the time is near when the production of aircraft will be a most important thing, commercially and in every other way in this country, and we have come to a stop. Are these manufacturers, are their plants to be dismantled? Are we to let this great industry that was born in America leave here again?

"The only customer, the only present customer is Uncle Sam. The commercial or other uses of aircraft have not yet developed, but it seems to me it would be an awful pity if we slumped back into the state in which we were before, and left to other countries, left to countries across the water the development of that industry that belongs to the United States by right of discovery.

"I got to thinking, while our reverend friend (Dr. Boynton) was making his eloquent address, of a sort of comparison between the aircraft industry and the story of the prodigal son—reversed. The aircraft industry was a younger son of Uncle Sam. He was younger than the steamboat. He was younger than the telephone, but he was still the son of Uncle Sam and he didn't go into a far country to spend his substance on riotous living, but he went out because his old man wouldn't have anything to do with him, and when he got to that far country he didn't sink to a level where he fed on husks, but everybody in the far country he went to made a lot of him, and he prospered greatly, although his father at home continued to sneer at him and never had a good word to say for him and never had done a good thing for him in his life.

"And then the time came around when the old man was in a lot of trouble and he wanted that boy back, and he said, 'Come back, son, and I will give you all the veal you can eat.' Now, he has got him back, and he began to feed him on veal and he found that the boy ate a lot of veal, and he found that it took a lot of trouble to teach him to get used to American clothes because he had been dressed in foreign clothes for such a long time, but he finally got things so that the boy was used to being at home and got to feel the way he felt when he went away, and then the time came when the old man really didn't need him any more, and that is the part of the story we have gotten to now.

"Is the old fellow going to say, 'I am not going to have this chap around me any more because he eats too much,' or is he going out into the back yard and going to raise his hand up in the air and say, 'I have made a damned fool of myself once about this boy, but now that I have got him back, I will keep him here, if I have to kill every calf I got on the place'."

John D. Ryan, Director of Aircraft Production, just recovered from a severe cold, came to the dinner at a personal sacrifice. He was welcomed enthusiastically as he was introduced to the manufacturers.

Mr. Ryan said that he had been called in to the aircraft production at a time, as Mr. Marshall says, when there was a great deal of discussion, a great deal of criticism, and a great deal of blame. "I say to you to-night in all earnestness, most of it was totally and entirely undeserved," Mr. Ryan declared, as the applause broke out.

"Aircraft production," Mr. Ryan continued, "had to find a way from nothing, to meet the demands of the American people, and brought to a point that was beyond all reason. People talked of clouds of airplanes, of tens of thousands of sparrows, and it was just as impossible to realize that dream as it was to realize any kind of a dream.

"Aircraft had to be built slowly, carefully. It had to be built to conserve, first the lives of these gallant boys who took these ships in the air. They had to be made sure, every wrinkle, every crinkle, everything that could be a menace to the life of these boys had to be taken out of them, if it was possible, before they were sent to fight across the line, and they had to fight across the line.

"The work that was done before me made it comparatively easy for me to win a good deal of praise, as I say, that I was not entitled to. The work of my predecessors, the work of the aircraft manufacturers of the United States was a thing that when I got into it and studied it, was amazing to me in its competency; and all it lacked was just time enough and just some organization to center it, to drive it in the direction, and to finish it.

"The manufacturers of this country, with singular devotion to the country, with great patriotism, and with the greatest earnestness that I have ever seen in any body of men, had built an organization for the manufacture of aircraft that certainly has never been equalled in the world, in the time in which it has been done.

"The brains that were in the aircraft organization at the time that I took charge of it had been well-directed; there were some things that might have been better done. There are things always that might have been better done, but in the main the work was well laid down. It was under way, and the manufacturers of this country who were making aircraft were doing a wonderful job, as far back as last May.

"I want to say that no association of my life has given me such

great pride and such great pleasure as the association with aircraft manufacturers, with the Department of Military Aeronautics, with these boys who took our planes and proved them and flew them and fought them.

“When I went to France in September, our planes had only just begun to reach the front lines. There were a good many of them there.

“In the first day of the fight at at St. Mihiel, I went from one pursuit group to another and one observation group to another and talked with the boys and asked them how they liked the American-made planes. And I think these boys sitting here to-night will tell you even then, after they had had them only a comparatively short time, there wasn't a single man of them who did not say that they would not take any other planes of a similar type into the air, if they could get an American-built plane.

“The greatest effort necessary to build aircraft, as you gentlemen know, to start the building of aircraft, was in the building of the engines. Is there anybody here to-night who doubts that the accomplishment of the American manufacturers of engines was one of the greatest accomplishments in the war, one of the greatest things done in the war? When the war ended there wasn't a nation on our side of the war—and I am sure there wasn't one on the other—who would not take every engine we could build for them of the types we were building. There was not a single nation in the war that did not want more of what we were making, than we could build for them.

“And we did not do so badly. From the time we began, we built more engines, and we built more planes, month for month, from the time we began than any nation in the war built from the time it began. We had more engines ready, and we had more planes ready, month by month, from the time we commenced, than any nation in the war had month by month from the time it began.

“The American manufacturers of aircraft, the American engineers, with their ingenuity, their brains, their patriotic devotion, the tremendous work they put into it, were building so well and even so fast that the day the armistice was declared, there were 686 American planes at the port of embarkation that could not be loaded.

“That was not the fault of the shipbuilders. Mr. Marshall gave us more credit than we were entitled to. But the reason for it was that while we were building a good many planes, a great many other people were building other things that General Pershing and the

people on the other side wanted very badly, and they were taking trucks and ordnance and other things that they needed very badly, and leaving aeroplanes for the last few days, but the fact remains and we have it to our credit that we had more planes ready for them than they were ready to take.

“It was a great adventure, and we are all proud of it.

“I hope that what has been accomplished in aircraft, in war times, will be duplicated to a great extent in peace times. I haven't any doubt that there is a great peace future for aircraft. I haven't any doubt that the men whose brains, whose money have been put into aircraft will go on developing it, perfecting it, making it so necessary to the life of the world, that the peace requirements in time will exceed the post-war requirements.

“I think the peace requirements—and I don't believe I am over-optimistic—will in time startle the world. I don't think it is coming to-day, and I should regret very much if it were pushed too much. I think with care and caution and development, and trial, that the aeroplane can be made as necessary in peace, almost as it is in war, and I believe it is in good hands. I believe the manufacturers of this country, who are in the aircraft business to-day, will see it to their own interests to proceed cautiously, carefully and make as few false starts as possible, develop it on broad lines and bring it to the fruition it deserves.

“I should think that it would be plain to almost anybody that in the necessity for the defense of a great country like ours, with a great coast line like ours, a very extensive aircraft programme is a very desirable thing.

“I think the science of aviation should be encouraged in every possible way. I would have an academy of aviation, just as we have a military academy at West Point and a naval academy at Annapolis. I would educate the boys of this country, from the time they are boys, in aviation, strictly and almost exclusively, and I think that with the proper expenditure and the proper direction, that within five years from now an enemy fleet that attempted to reach the shores of the United States would be detected and located so far out at sea that it would be put out of business three or four hundred miles beyond the reach of the shore.

“I don't think there is anything in the nature of a dream about that. I don't think that anyone who studies what has been accomplished in aviation, and who thinks what might be accomplished, can consider that at all a dream.

"We now have planes that have a long range; we will have planes with a longer range, not necessarily the fastest planes, but planes with a long range, that could absolutely detect the presence of a hostile fleet on its way to these shores, at least 500 or 600 miles before they could reach us. Not deprecating in any way the great naval defense that we want in this country, and that we must have I would say the planes could locate the fleet and the navy could destroy it, it could be told where it was and it could be destroyed before it could reach us.

"I think it is a great pity that the brains in the aircraft organization, naval, as well as in the army, should be scattered. I think that the civilians who have come into this work, able engineers who have gone so far in this work. should be used, should be kept, should teach the younger generation all they know, pass it along, and that these great organizations that have been gotten together under the stress of war should not be dissipated and go back to their civilian employments without leaving with the country the benefits of all they have learned.

"I think that the great manufacturing organizations should not be destroyed, or allowed to fall into disuse. I don't advocate the building of great numbers of aircraft for military purposes. I don't think it is necessary. But I think that sufficient encouragement and employment can be given to the well-developed aircraft factories of this country to keep them in the aircraft business, to induce them to make every discovery, to do everything they can to promote the science of aircraft. The organization should be kept intact, the men who are able and who have done this thing should be kept together as far as possible. It would be a small expense and, God knows, it might be a great measure of economy some day.

"It has been a great thing to be identified with the development of aircraft during this war. As little as some of us have had to do with it, it is a thing that we will be proud of to our dying day. To be associated with you men who have done this wonderful work in the building of aircraft, to have served these boys who have carried our craft across the enemies' lines, and they had to go across the enemies' lines because he couldn't come across ours—who have destroyed him, has been a thing that one can hand down to his children with great pride.

"I say some people have criticized our work in aviation on the front. Some people have said we have been too reckless. The

French told me that our boys were too reckless. Some of our own good friends have said that our boys were too reckless, but God bless them, that is what won the war—the fact that our boys were too reckless.

“I saw them in France, when the clouds were low, and when it wasn’t a fit day for anybody to take the air. I have seen them go out and fly 50 and 60 meters above the ground and bring back a complete record of what was ahead of them. General Pershing told me when I talked with him, on the second day of the battle of the Argonne, that no army ever went out with the information as to what was in front of it, as the American army did in St. Mihiel and the Argonne.

“And these boys that are sitting in front of us and thousands of boys like them, went out and got that information.

“It is too bad that many of them have never come back, but it is a glory to them; it is a glory to their people; and it is a glory to the country that we have the kind of boys that will do that kind of thing; and it ended the war much before it would have ended otherwise, if we had been conservative and careful.

Lieutenant H. H. Emmons, a Detroit lawyer closely associated with the automobile business, who, when the war broke out, entered the naval service, and then was taken over by the bureau of aircraft production to take charge of motor production was the next speaker.

The requirements of the aircraft were of two classes—first, for training; second for combat,” said Lieutenant Emmons. “For training we had already in America two engines that could do the work—the Curtiss and the Hall-Scott. There were others that could have helped, but time didn’t suffice to enable the board to use them. There were planes to go with them, and,” the officer said, “we adopted those two and pushed the production of them, with the result that the training planes were put in our fields, with something over 16,000 engines to fly them before the war was stopped.

“Now, to understand what that means,” Lieutenant Emmons particularized, “you should know what the situation was when this was started. For the eight years prior to 1918, the Army had ordered 59 airplanes and had received 54. During the year 1916, the Army had ordered 366 planes and had received 64.

“In other words, for the nine years prior to 1917 the Signal Corps of the Army had received the enormous sum of 188 airplanes. That was the equipment that they had had up to the date that we started

this business, and that was all that they knew about them. Now, from that we had to start with a program laid down by the joint army and navy technical board, calling for over 9,000 training planes and over 20,000 combat planes.

"Now you made 9,000 of the training planes; you made the 16,000 training engines, and every one of them had been delivered and put into service, gentlemen, before the armistice was signed.

"On the combat engine side we were oppressed with the same multiplicity of advice, as a result of which it was determined to put our main effort upon the Liberty engine. On the 19th day of May the first stroke of the pen was made to design the Liberty engine. The first engine was built complete and delivered in Washington on the 4th day of July, less than six weeks. It was extended into a twelve-cylinder engine, and the first one was built and passed the 50-hour test by the 25th day of August of that same year and was pronounced a success and ready for production.

"We started to produce that engine which was rated at a horse power of 330. When we had tooled and jigged up for it and gotten the factory ready and had produced several hundred of them we were told to increase the horse power. It was boosted to 375, with the resulting changes in the tools and equipment. When we had made some 400 or 500 of them we received our final instructions from abroad, and, I might say to you, that most of the things you have felt disposed to criticize, you will find they were done by us because we were told by the authorities under whom we were working that that was what was wanted, and that we should do it.

"We received our instructions from the other side that if we could produce an engine of 400 horse power or upward, we would have the engine that would do wonders in 1917 and 1918. Many changes were required to get that large engine, and on the 29th day of May, 1918, one year after this engine was started to be designed, we had passed all those difficulties, had engineered and developed it, put it into a manufacturing proposition and delivered into service over 1,100 of them.

"Now that is an accomplishment that never has been equalled in industry anywhere.

"Now, from the 29th day of May, until the armistice was signed, the production of these engines jumped by leaps and bounds, until during the month of October the production of Liberty engines was 3,878, or over 150 for every working day in that month.

"The total engine production of all types for the month of October

was 5,603, or over 200 for every working day in the month, and as my friend, Gen. Cormack told me, 5,603 is more engines than were produced in any one month during the war by England and France combined.

"Now we had, gentlemen, under contract for production, 95,995 aviation engines, at a total cost of engines and spare parts of over \$450,000,000. We had them in production in the finest plants that are in the world for the production of machinery and particularly motors.

"On the 29th day of November, exactly 18 months after the first scratch was put on the paper to design the Liberty Engine, we had produced and delivered into service 15,600 Liberty 12-cylinder engines. We had produced and put into service of all kinds of engines, training and combat over 32,000, that is over a third of the total that we had ordered built. Now, one may ask where those engines went, and it is quite interesting to know where they went because there has been some question asked about that.

"Of the Liberty combat engine 5,327 of them went to aeroplane plants to be installed in planes, or to accompany those planes as spare engines, and over 3,000 of the D. H. 4 planes with the extra engines had been produced and started for the front when the armistice was declared. Of these Liberty 4,511 had been delivered to the American Expeditionary Forces in France as engines only, not accompanied by planes. 3,742 engines had been delivered to the Navy, and we had delivered to the English, French and Italians 1,089 engines for their use, and we had put on our fields for the training of our aviators 907 of these Liberty engines. That will give you some idea of the extent to which this production had gone. By January of this year we would have been producing over 6,000 aviation engines of the Liberty type per month, and by April of this year we would have been producing 10,000 engines per month of every type. That is what the manufacturing interests of this country have done.

"We have delivered over 700 balloons by the time the armistice was declared. Our balloon companies went from the ships direct to the front, thoroughly equipped and prepared, both as to men and material, and took their place on the line at once.

"We have heard about the millions and the billions of profits that the manufacturers are going to make. We all know that that is incorrect, that the manufacturer who comes out of this work even is doing a very handsome thing by himself, under these circumstances.

Charles F. Kettering, president of the Society of Automotive

Engineers, said in his speech which followed, that the aircraft business at the present time reminded him somewhat of the situation of having tremendous locomotive factories already building locomotives, shipping to some country where they had railroad tracks, suddenly being cut off from that supply and then trying to keep the locomotive business going. "We have got to build some railroads, and we have got to go into the part of the aircraft, which has to do with the actual operations of it," he concluded.

Mr. Otto Praeger, of the Post Office department, in charge of the aerial mail, now spoke briefly. His remarks will be found in the section of this volume which reviews the Post Office achievement.

The toastmaster: The night is well along. Unfortunately, General Kenly had to leave before we could get to him, so we will save him for another time.

Before closing, I want to make one announcement, namely, that on February 27th and on to March 6th there will be an Aeronautic Exposition, held under the auspices of the Manufacturers Aircraft Association at Madison Square Garden. We want the help, the aid, the encouragement of every man here to-night to make that show a success, not for ourselves, but for the interest and for the development of the art. Will you help?

The members of the Association and the committee wish to thank you for your being here, for your patience, and for your enthusiasm. Good night! (Applause).

Adjournment.



The Banquet of the Manufacturers Aircraft Assoc.



at the Waldorf-Astoria, New York, January 7, 1919



INGLIS M. UPPERCU
President Aeromarine Plane and Motor Corporation

AEROMARINE PLANE AND MOTOR CORPORATION

KEYPORT, N. J.

INGLIS M. UPPERCU	<i>President</i>
JOHN W. GERMAN	<i>Vice-President</i>
E. deB. NEWMAN	<i>Secretary</i>
S. HARRY JOHNSON	<i>Asst. Secretary</i>
LUCIEN R. BURNE	<i>Asst. Secretary</i>
DANIEL G. CROASDALE	<i>Asst. Secretary</i>
AUGUST FAUX	<i>Treasurer</i>
HINSDALE SMITH	<i>General Manager</i>

Directors

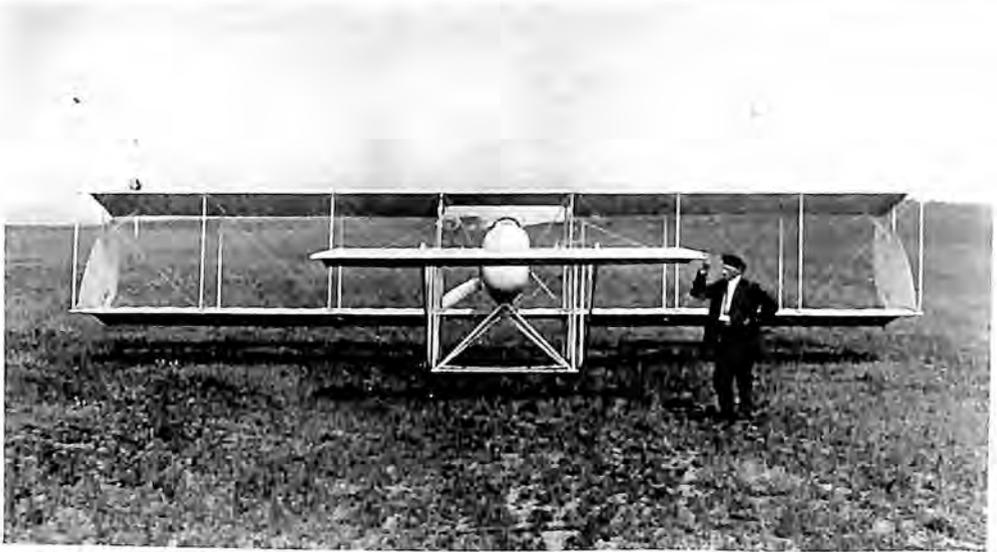
INGLIS M. UPPERCU E. DEB. NEWMAN
JOHN W. GERMAN

PLANT—Keypport, N. J.

ONE of the aircraft factories on which the United States Navy relied during the war for the training planes which developed its excellent air service, was a plant of sixteen buildings and fourteen hundred workers situated at Keypport, N. J., on the edge of Raritan Bay. This was the Aeromarine Plane and Motor Corporation. This Corporation, Navy Officials said, turned out construction of especial strength and accuracy. Indeed, the Navy Department thought so highly of the work done at the factory that it established on the Corporation's grounds a school for carpenter's mechanics, and used the Aeromarine factory as a class-room for these future Government workers.

The story of the Corporation explains why the work done by it was so satisfactory. As a working concern, the firm has not had a long history. While it existed in a different form as early as 1908, the Aeromarine Corporation was not established under its present name until March, 1914, and did not become actually engaged in the production of military machines until 1916-1917. But its present staff is one which has had an interest in aeronautics from the first—an interest from the designer's, the flyer's and even the promoter's standpoint. The coming together of the staff in 1916-1917, created the present company, but through its individual members the Aeromarine has contributed to the development of flying even before public flights were made in the United States.

Typical of the men who have made the Company's success, is the



An Early Aeromarine Machine

President, Inglis M. Upperco. Mr. Upperco had a pioneer's interest in aviation and a pioneer's realization of what industrial possibilities lay in aeronautics. He has furnished funds for aeronautic experiment from 1908 onward, and has been responsible, through his backing and his enthusiastic interest, for much that has been done in the way of aeronautic development. While essentially the business head of the organization, he has always been a practical worker from the scientific standpoint. The recent development of the Corporation and its present promise are alike attributable in no small measure to him.

Charles F. Willard, the Chief Engineer of the Corporation, has had as early, if an entirely different type of connection with aeronautical development. As early as 1900, the problem of motors for boats and other vehicles had caught Mr. Willard's interest, and from that time on he was at work on the development of gas engines. Like Glenn H. Curtiss, he found the study of engines conducive to the study of flying machines, and in 1908 was working in New York City with the Aeronautic Society, and had, indeed, designed machines of his own when Mr. Curtiss won the Scientific American Trophy by flying one kilometer with the "June Bug." The Aeronautic Society, it will be remembered, ordered a machine from Mr. Curtiss, and one of the stipulations attending the order was that instruction should be given in flying to two of its members. Mr. Willard was one of



Aeromarine Original B-Type Pusher. This machine was used in Flight Exhibits in Venezuela

these to receive this training. He flew in exhibitions from 1909 to 1913, flying not only the first Curtiss machine, but many others. At the same time he did not drop his interest in the designing of airplanes. From 1913 to 1914 he was Chief Engineer for the Glenn L. Martin Company in Los Angeles, California. In 1915 he became engineer for the Curtiss Airplane Company, and assisted in the design of their large flying boats. In 1916 he was associated with Messrs. Lowe and Fowler in establishing the L. W. F. Engineering Company, the initials standing for the names of the founders, although they also may be applied to the laminated wood fuselage body, which Mr. Willard designed, believed to be the first monocoque type of fuselage to be built in the United States. The body was designed in California, and the entire machine, as produced by the L. W. F.



CHARLES F. WILLARD



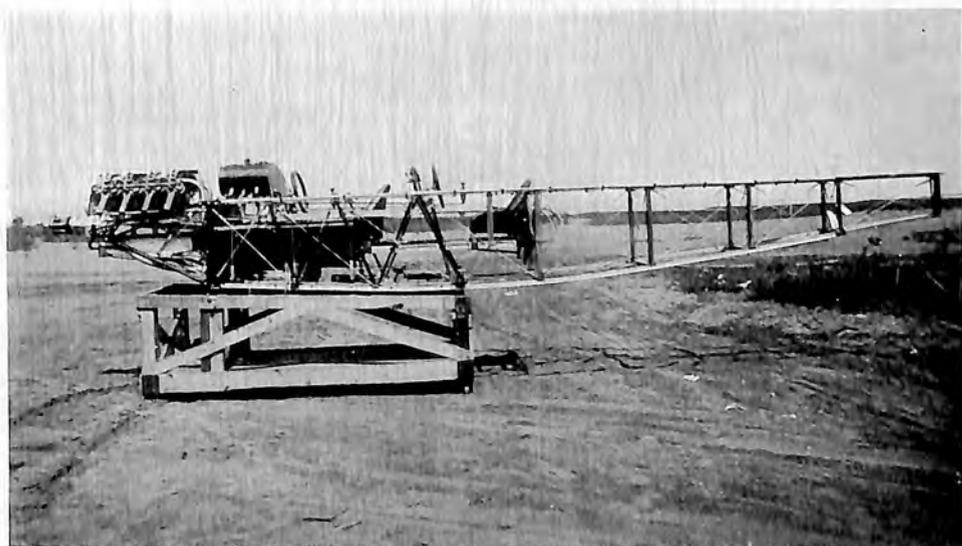
FRANK E. BOLAND
Flying at Mineola, Feb. 17, 1910
HINSDALE SMITH E. de B. NEWMAN
Model 40, Aeromarine



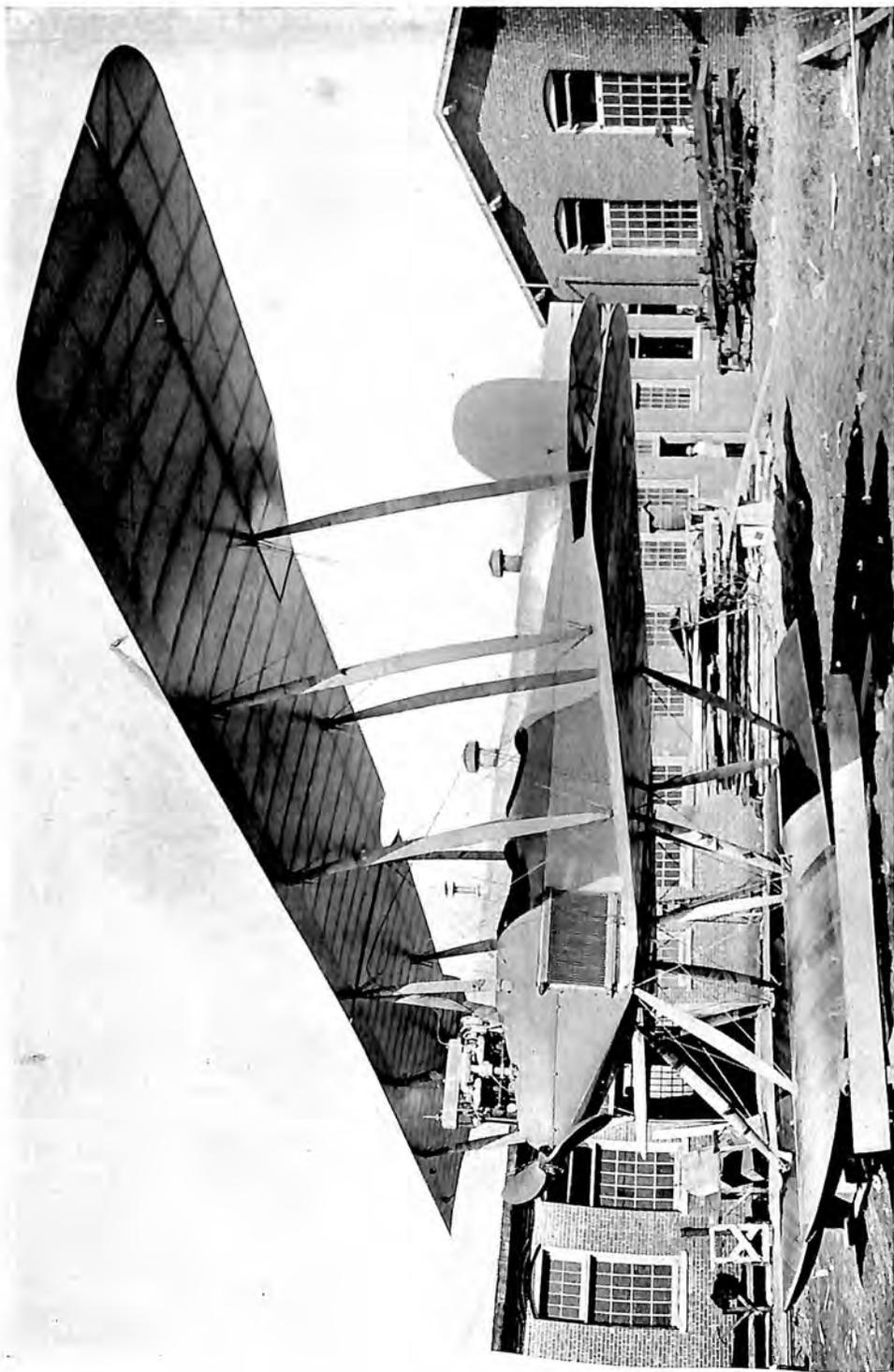
The Original "Aeromarine" Flying Boat

Company a few months later, was planned in detail by the inventor in Buffalo.

Early in 1916, Mr. Willard came to the Aeromarine Plane and Motor Corporation as its chief engineer, and he immediately began to assist in directing the building policy of the Company. His long experience and great skill have been of inestimable value. A



Secondary Fuselage Assembly, Aeromarine Model 39-B.



Model 39-A, with Hall Scott, 100-H. P. Engine. The first machine delivered to the Navy, June, 1917



Group of buildings showing from top to bottom: 1—The U. S. N. School for Carpenters' Mates on Aeromarine property; 2—Executive Offices of Keyport plant; 3—Flying Field for Visiting Army Planes; 4—Wing of Main Assembly Building; 5—New Wing for Flying Boat Hull Construction; 6—The Old Factory at Nutley, New Jersey.



Model 39-A, Front View

testimonial to his capacity was his appointment by the Aircraft Production Bureau as its representative in Europe. Mr. Willard was deputed to make an inspection of all European aircraft types and to report to the Bureau concerning their fitness for adaptation to American manufacture.

The General Superintendent of the Aeromarine Company, Mr. Hugh Robinson, was likewise an early and enthusiastic votary of flying. In 1907 he was already experimenting with gliders and airplanes, and in 1908 built a monoplane believed to be the first of its type made in this country. The machine was exhibited at the St. Louis Centennial in 1909 by Mr. Robinson. Exciting years followed. There was service with the Curtiss Company in California in 1910, experimental work with Glenn Curtiss on North Island, San Diego, Cal., in connection with the world's first successful hydro-aeroplane, and further exhibition flying lasting through a number of years. Mr. Robinson was associated with the building of the first successful flying boat with power plant within the hull. He introduced the first Curtiss hydro-aeroplane into Europe. He made the first long-distance flight in a hydro-aeroplane, going from Minneapolis to Rock Island, a distance of 375 miles, in 1911, and carrying the United States mail. He was a holder of the world's unofficial altitude record for the hydro-aeroplane—9,680 feet, from 1911 to 1914. He participated in the first hydro-aeroplane meet at Monaco, and the



Side View of Model 39-A

total of his exhibitions in the United States, Canada and Europe reaches into the hundreds.

In the late summer of 1917 Mr. Robinson left the Curtiss Company at Buffalo to become General Superintendent of the Aeromarine Plane and Motor Corporation at Keyport, N. J.

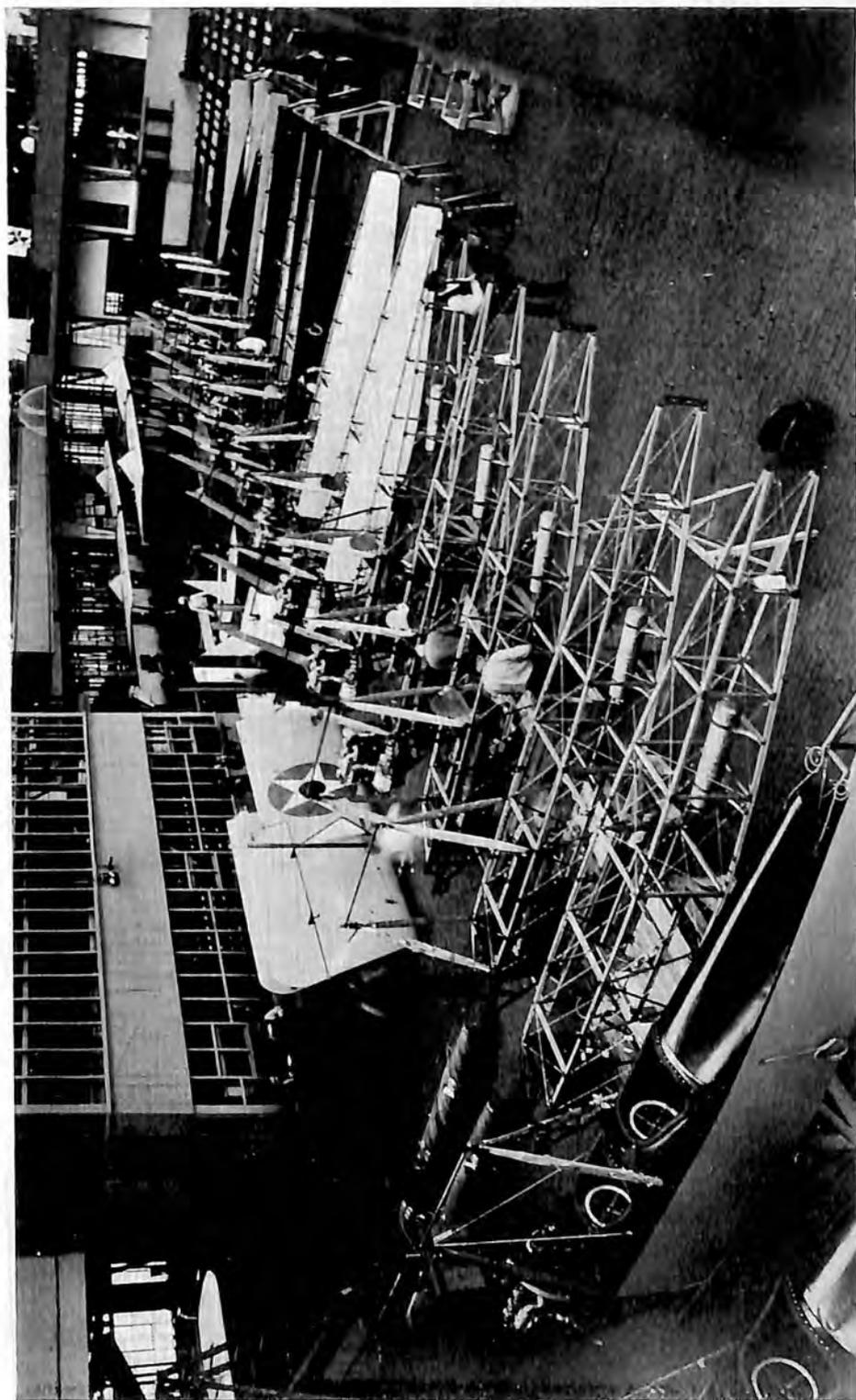
One of Mr. Uppercu's early associates in the period of experimentation, which characterized the Company's early existence, was Mr. E. deB. Newman. Mr. Newman was, in early days, Vice President of the Corporation, and managed exhibitions in South America, Canada, Jamaica, Costa Rica, Trinidad, etc. He is, at present, the Secretary of the Company.

The experience in aeronautics which these members of the staff represented was supplemented by a different but scarcely less valuable type of experience when Mr. Hinsdale Smith came to the Company in December, 1917, as General Manager. He had been president of the Springfield Metal Body Company, a pioneer company in the building of metal automobile bodies in the United States, from 1898 to 1916. He had built the first six-cylinder car in this country in 1896. His knowledge of an industry somewhat similar to the aircraft business, which had already passed the stages of early development, has been very valuable to the Corporation.

The first Government work of the Aeromarine Company, after its reorganization in 1914, was the building of land and water machines



The Main Assembly Floor, Aeromarine Factory, Keyport, N. J.



Another View of the Assembly Floor

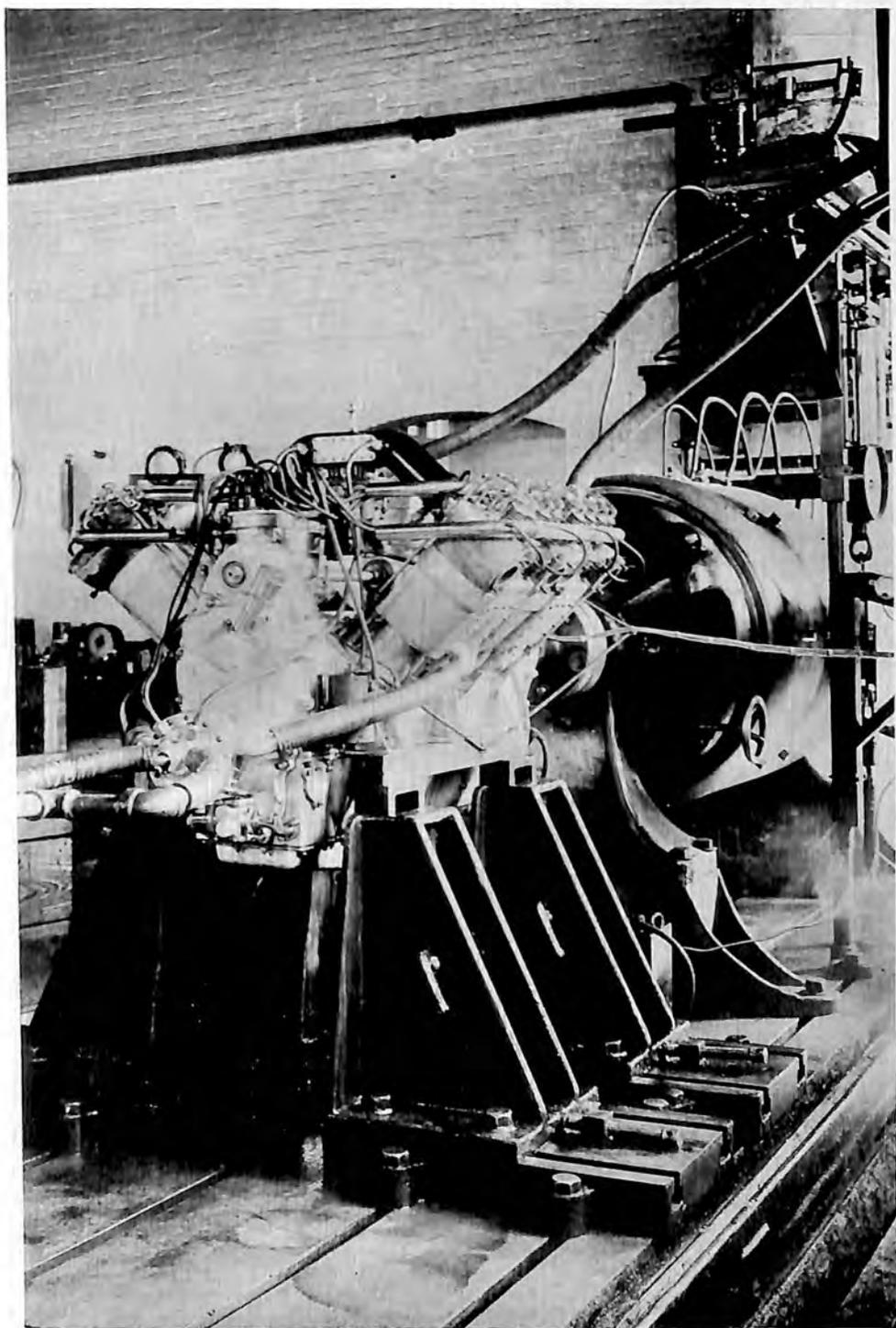


Aeromarine Model 39-B

for both the Army and Navy. The Company laid out a definite plan of building machines of its own design only. The first, a two place tractor biplane training machine type, equipped with a 100 H. P. Hall Scott motor, gave a very satisfactory performance for the Signal Corps. In April, 1917, the first Government orders for Naval



Model 40—Flying Boat



Aeromarine B-Type Motor, 8-Cylinder, 130 H. P.



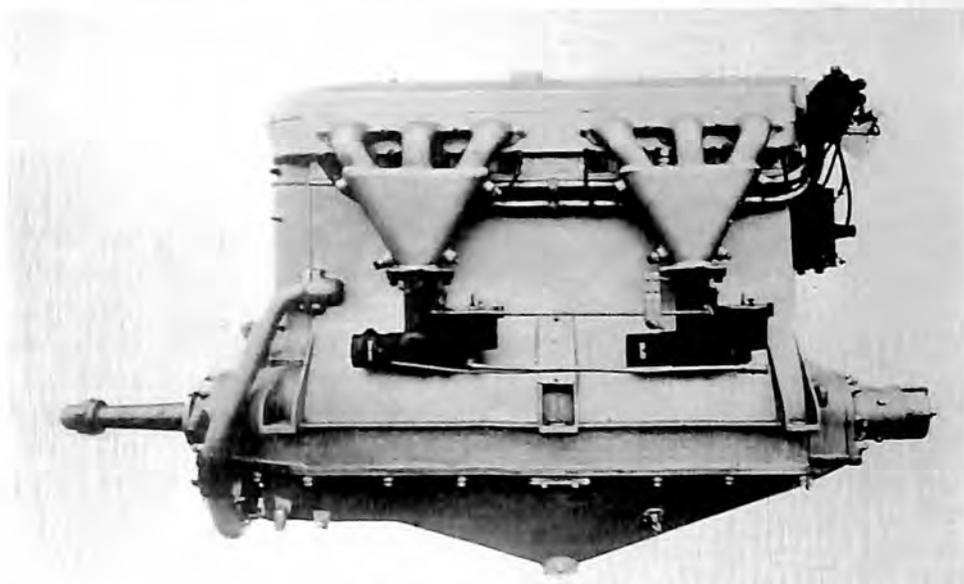
Model 39, a modification of 39-B. This plane competed for the Curtiss marine trophy, and made an excellent showing.

work were received, and the Company immediately devoted itself to following out a three-fold production programme, based on Aeromarine hydro-aeroplane designs. The types produced were all training machines, embodying three different types of hydro-aeroplane construction. 39-A type, for instance, was a twin float hydro-aeroplane; 39-B was a single float machine, otherwise of the same design. Model 40 was a flying boat. It is, of course, understood that the flying boat differs from the hydro-aeroplane in that it has a body-like hull, which serves as a support in landing on the water and also contains the seat for pilot and observer, etc. The hydro-aeroplane, on the other hand, has a body or fuselage to support the motor and

carry the pilot, and below this, pontoons which support the machine in landing. All of these types attained a maximum speed of approximately 85 miles per hour with the motors which they used, and all of them had a wing span of about 46 feet. The efficient construction of these machines resulted in demands upon the Company which eliminated



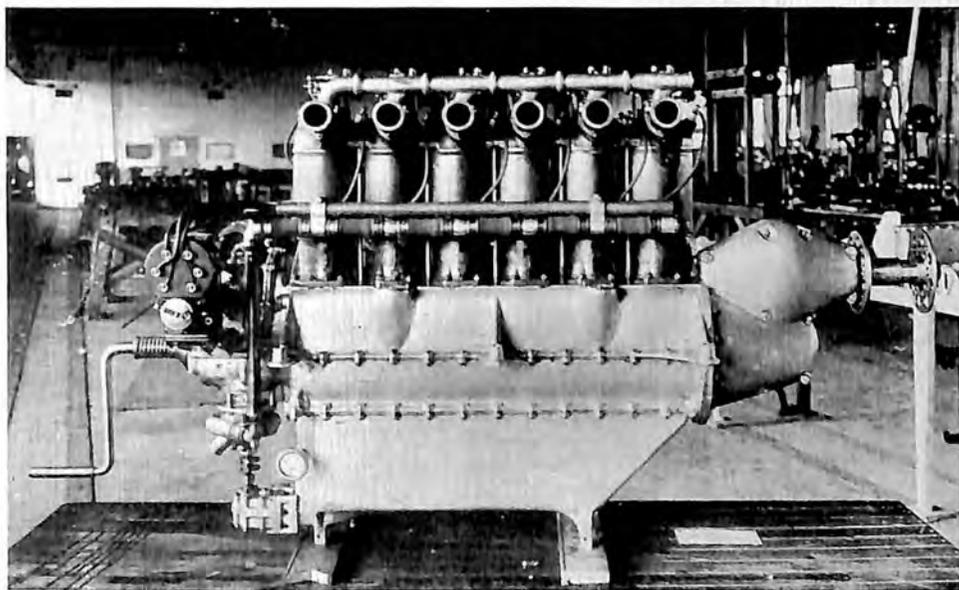
Model 39-A taxiing on the water



The Aeromarine Type L Motor

it from participation in the war-time manufacture of land machines early in the war.

For more than one year before the signing of the Armistice, there was a steady delivery of planes to the Navy Department, and at the same time a steady growth in the extent and capacity of the plant.



The original 6-cylinder, 90-H. P. Aeromarine Motor, built in 1914



The Aeromarine Type L 150 H.P. Motor, end view

The weight of the Aeromarine hydro-aeroplane, in relation to the lifting power of the engines used in them, offered a distinct advantage for training purposes which the Navy Department was ready to appreciate. The three types showed are markable capacity to sustain flight during any weather conditions. They made continuous training at United States Naval Training Schools a possibility.

At the conclusion of the war, the plant at Raritan Bay had a property of sixty-six acres upon which had been erected sixteen model fire-proof buildings—most of them two-story—with a total floor space of 125,000 square feet. A club house, restaurant, bowling alleys and dance hall had been constructed for employees. Every department was equipped with the most modern machinery.

Automatic screw machines, lathes, grinders, the latest type of milling machines, sand blast, electric and ox-acetylene welding outfit, enamelling ovens, galvanizing, copper, and nickel-plating equipment were part of the machinery installed. The plant included a dip-brazing outfit and a complete tin shop for the making of tanks, etc., and a dope room equipped with a special exhaust system for the purification of the atmosphere from dope fumes.

Nor was the condition of the mill less satisfactory from the modern industrial standpoint. All types of machinery needed—including veneer presses, belt and disc sanders, all types of moulding and variety machines were found within the mill room's equipment.

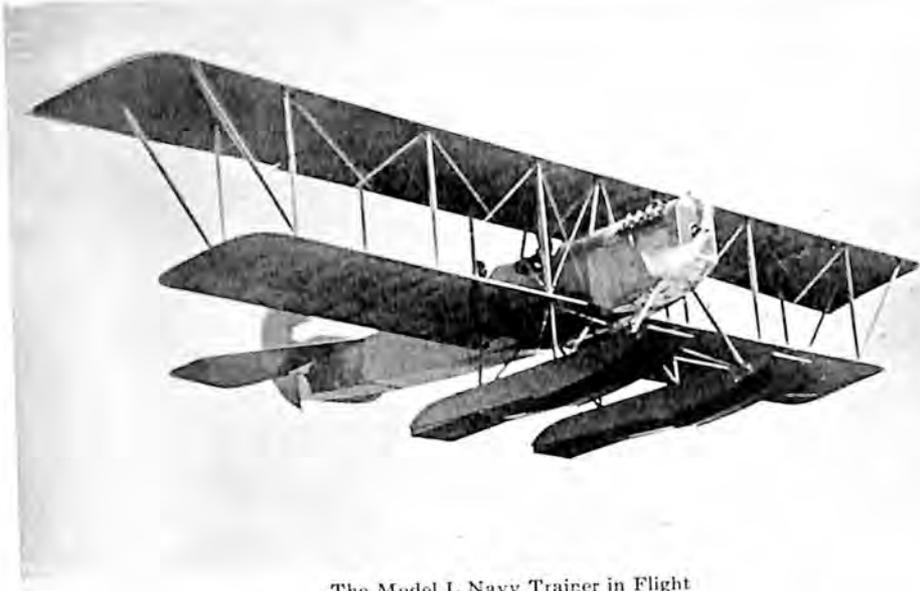
In addition to the development of land and navy machines for flying, the Company has been interested in the production of motors. It has developed two types—the B motor, 135 H. P., and the L type, 6-cylinder, 130 H. P. engine, which will be seen in the Manufacturers

Aircraft Association Exposition. There is also a 180 H. P. geared motor of the same type as Model L. These engines have been in development for some time. Their advantages are extreme simplicity, accessibility and durability without undue weight. The L type, for instance, develops with its six cylinders more than 1 H. P. for every three pounds of weight. It is especially adapted to training and sporting machines. It has been used in one of the new products of the Company—the Aeromarine Flying Boat, Sportsman's model—which promises to be one of the most popular of marine flying craft in the near future.

The policy of the Aeromarine Plane and Motor Corporation with regard to the future is a definite one. It plans to make a specialty of cargo and heavy freight-carrying machines—both land and naval—as well as sporting and military machines. The engineering staff has drawn up a number of designs for such machines, and investigation of the conditions likely to govern commercial aerial travel has been made. Nevertheless the attitude of the Company is one of adaptability to demand rather than one which attempts to force an individual development upon a buying public, whose wants are bound to show great variety. The prospective customer will be dealing with a firm having expert knowledge concerning the possibilities of commercial planes flying over land and water; but the Company, while carrying certain stock designs, will not push these upon the attention of the buyer. The question asked will be, "What function is the required machine to serve?" and the Aeromarine Company will propose to build according to the uses to which the product is to be put. This policy, which the Company is especially adapted to pursue by the amount and variety of experience represented in its personnel, will, it is felt, carry the Aeromarine Plane and Motor Corporation along with the full tide of the rising industry.



HUGH ROBINSON



The Model L Navy Trainer in Flight

THE BURGESS COMPANY

MARBLEHEAD, MASS.

FRANK H. RUSSELL	<i>President</i>
GREELY S. CURTIS	<i>Treasurer</i>
E. J. BARNARD	<i>Manager</i>

Directors

W. W. MOSS	G. S. CURTIS
J. E. KEPPERLEY	F. H. RUSSELL

PLANT No. 1—Located off Gregory Street, Marblehead, Mass.

PLANT No. 2—Located off Orne Street, Marblehead, Mass.

“WHAT is it most like?” echoed a flyer with wide previous experience to a question concerning the nature of flying. “No—not a motor car or a motorcycle—why—ever handle a fast yacht or motor boat? It’s most like that!”

An aerial ship, an airship!

The aeroplane was, indeed, christened the argosy of the air long before it became an actuality—it was the “aery navies grappling in the central blue” which Tennyson saw in Locksley Hall in 1842, when he wrote the eight lines which prophesied the aerial development of the recent war. And when aircraft became usable, it did not take aviators long to top them off with an aeronautical name.

The layman or designer may speak of the airplane or the aeroplane, of the monoplane, biplane, or triplane; but to the man who handles the wheel or "stick," all are plain "ships."

That the man who learned to shape fast sailing boats for sea racing should become a builder of flying boats and hydro-aeroplanes was accordingly a fact entailing the most natural of changes. The W. Starling Burgess Company, Ltd., was famous not many years ago for its speedy boats, particularly those of the Sonderklasse; its seacraft were successful in many a sporting event. But to-day the Burgess Company has turned the former shipbuilder into one of the well-known figures in commercial aviation,—from the maker of fast seacraft to a producer of airplanes, whose services both the American and foreign governments have sought in time of stress.

What called to life the firm which the United States Government has depended upon for training seaplanes? What is the story of its growth?

The firm was born when, in 1909, an interest in flying took possession of Mr. W. Starling Burgess. The interest proved practical. The early months of 1910 saw the launching of his first successful air machine. It was the joint production of Mr. Burgess and Greely S. Curtis.

The Flying Fish, as the new machine was called, was in many



The First Burgess Hydro-Aeroplane



A 1912 Burgess Seaplane Model

ways anticipative of later air seacraft construction. It was an open construction biplane with a four-cylinder motor of approximately 30 H. P., which had a pusher propeller and was mounted between the wings. The machine had outriggers in front and behind, on which were set both forward and rear elevators and a rear rudder. Lateral stability was planned for by the installation of a number of vertical fins of triangular shape projecting above the top plane, the theory being that any lateral gusts encountered would so act upon the side area presented by the fins above the center of gravity of the machine as to neutralize the effect of the gusts on wings and main structure. Thus any tendency to capsize laterally was minimized. This is a device still retained in certain modern types.

The Flying Fish flew. On April 18, 1910, at Plum Island, Mass., with W. Starling Burgess and Greely S. Curtis, piloting it in turn, it proved that, whatever might be its crudities, it could fill the elementary purpose of its construction. It could maintain horizontal flight through the air.

Other machines of this type were constructed during that year. They were flown by William M. Hilliard, then the Company aviator, and by A. L. Pfitzner, who became assistant engineer and manager of the Burgess Company and Curtiss, Inc., in June, 1910.

Mr. Greely H. Curtis, who introduced his name into the young firm, had had an earlier aeronautical experience than anyone in it. A

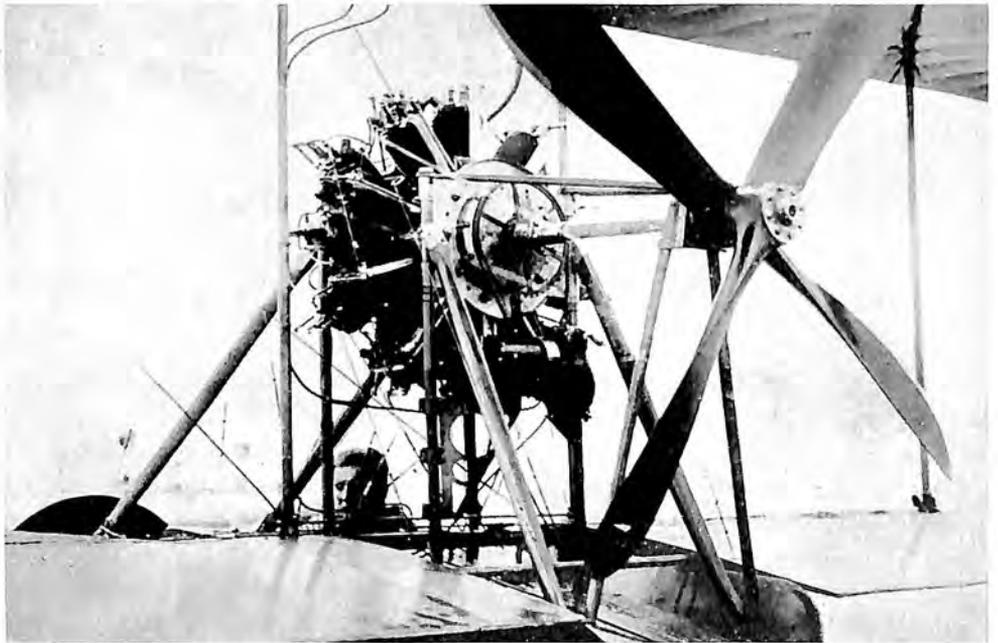
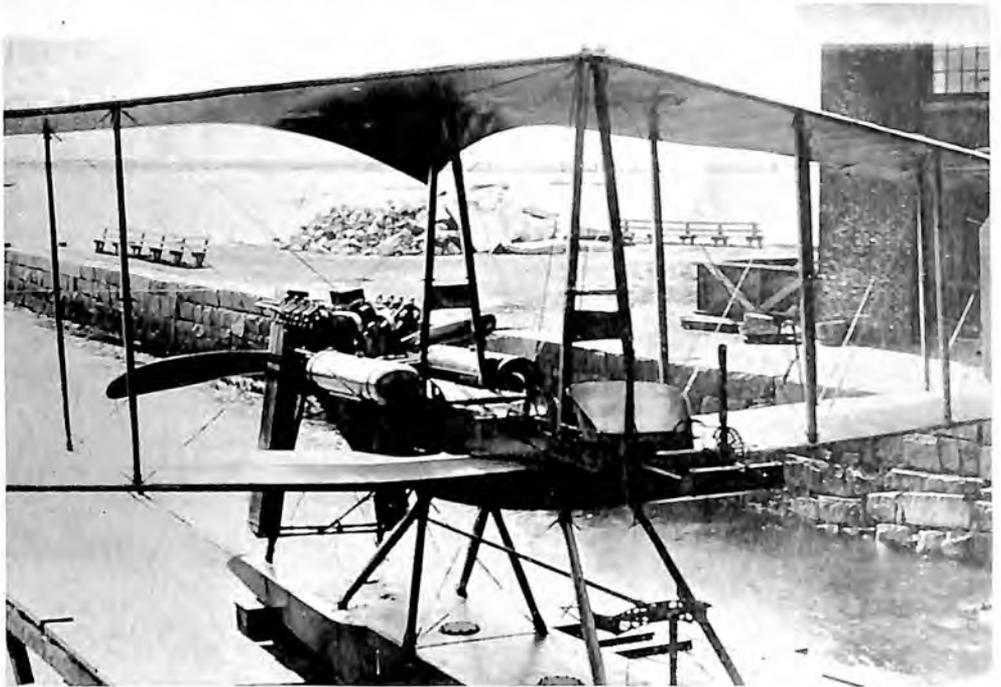


Burgess Tractor, showing first enclosed fuselage in United States

graduate of Harvard and Cornell, he had been deeply interested in the problem of flying. His enthusiasm had brought him to Lichtenfeld, Switzerland, where he had worked with Otto Lillienthal, the father of the glider. Mr. Curtis, after his early aerial adventures, became Hydraulic Engineer of Boston Fire Department, and later of the National Bureau of Fire Underwriters. He is the inventor of the self-computing fire stream gauge.

From its experimental adventure with the Flying Fish, the Company passed to some work which is significant in aviation history. It comprised the building of experimental machines for the noted aviators, T. O. M. Sopwith and Claude Grahame-White. Naturally, these machines outclassed the Flying Fish. Their ability to maneuver and their inherent safety both marked a great advance. Indeed, Mr. Grahame-White ordered a number of the machines designed for him and used these to start his flying school in England. Among pioneer types, these Burgess airplanes stand out as being remarkably successful.

But labor was soon undertaken of even greater significance. The great figures in aviation at that time were the Wright Brothers. The Burgess Company and Curtis were now to arrange with the Wright Company of Dayton, Ohio, to build machines under the Wright patents. Various types of Burgess-Wright machines rapidly appeared. The type F for land flying, a modification of the Wright Company's model B, was used for training of military



Views, front and rear, of Anzani Power Plant of Burgess Model I Flying Boat



Burgess Model I Flying Boat

and civilian fliers. It was a two-passenger model with two pusher propellers, and a four-cylinder motor driving through chains. The pilot and pupil were seated on the lower wing, entirely exposed to the air force. But one important advance in airplane design was marked by the elimination of the front elevator. This was an early step toward the securing of an inherent longitudinal balance by the use of stabilizer surface situated in the rear of the machine.

The Wright connection brought to the Burgess Company James W. Davis, its present chief engineer. He was a graduate of Colorado College. He had been associated with the Wright Company for several years, at the flying school at Montgomery, Ala., the first in this country. He was to be associated with the development of all the early Burgess machines, including their adaptations of the Dunn inherently stable machine.

Although busy with building machines, the Company was, nevertheless, as interested as ever in flying them. It opened a flying school. Under Harry N. Atwood as aviator in charge, a number of young men were soon learning to fly. Some of these Burgess pupils were later to win world renown. As pilots, demonstrators, or students, such fliers as Howard W. Gill, Norman Prince, Charles K. Hamilton, Claude Grahame-White, T. O. M. Sopwith, Walter Brookins, Phillips Ward Page and Clifford L. Webster, were at this time associated with the Company.



Gordon Bennett Racer, Built by Burgess Company

Frank H. Russell, well known as the General Manager of the Wright Company, became associated with Mr. Burgess in October, 1911. Mr. Russell's experience in building aeroplanes and Mr. Burgess's vast experience in designing and constructing light racing yachts were now to become a factor in the Company's work. It led the aircraft builders into the uncharted realm of marine flying. Much experimental work was done. The best possible design and construction of hydroplane floats or pontoons was sought. The first result was an adaptation of the model F land machine,—a remarkably successful hydro-aeroplane employing twin-float pontoons in the place of the usual wheels and chassis. The production of a successful hydro-aeroplane opened up a new field in aviation. It gave a natural outlet for the energy and sporting proclivities of a number of wealthy men who had become interested in aviation. Danger had been the chief bar to popularity. But the larger degree of safety in marine flying removed what had hitherto been the only important objection to aviation as a sport.

The new Burgess machine became immediately popular. A number of hydro-aeroplanes were sold for sporting purposes, Robert J. Collier, W. E. Scripps, and Howard W. Gill being purchasers.

Aviation had, by this time, become popular. The years 1911 and 1912 were characterized by many aviation meets held throughout the country. The Burgess Company felt the rising interest and

determined to design and construct a racing monoplane to compete with French aviators. A small, fast machine was built, fitted with the Gnome 140 H. P. rotary motor. The Gordon Bennett Racer, as it was called, was entered in the Gordon Bennett Cup Race held in Chicago in 1912. The speed which it attained was better than 120 miles an hour—phenomenal in those days. The prime mover in the building of this American machine was the late Mr. Norman Prince, now internationally known as the organizer of the famous Lafayette Escadrille.

An even more remarkable achievement in airplane building was to follow immediately. In the summer of 1912 a prize was offered by Edwin J. Gould, through the *Scientific American*, for the development of a twin-engined airplane. The specifications of his offer demanded the possibilities of cutting out either one or two motors. A machine would thus be provided impervious to breakage in the power plant.

The Burgess Company and Curtis, in conjunction with Mr. Howard W. Gill, constructed a machine to compete for this prize. The machine was a biplane of standard Burgess model F construction. Two motors were mounted centrally on the lower wing, and drove, by means of chains, two sets of propellers—one set pusher and one set tractor. The propellers were driven in opposite directions to counteract any gyroscopic tendencies. Friction clutches were interposed between each motor and its corresponding pair of propellers making it possible to couple the motors together.

This machine met successfully full flying tests. It was the first twin-motor machine ever produced in any country. The prize, however, on the promise of which the machine had been designed, was withdrawn owing to the fact that this was the only machine constructed which fulfilled the specifications. The donors were unwilling to award the prize when but one constructor had achieved success. This was the first two-motored plane ever built and was the progenitor of the Handley-Page and Caudron, other two-motored types.

The Burgess Company was also experimenting at this time with the enclosed fuselage. Pilot and passenger had hitherto had no defense from the strong rush of wind attending flight through the air. It was realized that if high speed were to be sought for, those riding in the airplane must be given protection. It accordingly designed the Burgess tractor—model H. The new machine was mounted on 8-cylinder, 70 H. P. Renault air-cooled motor. It was a forerunner of the tractor type as now used throughout the world.



Burgess Floating Hangar

With complete protection to pilot and passenger, it attained a speed of 70 miles per hour, exceptional at that time for a weight-carrying machine. It was exhibited in New York, at the first Aero Show. It had the first enclosed fuselage and was adopted by both the Army and the Navy.

The attention of the War Department was immediately attracted. The Burgess tractor was tested by army aviators and was adopted and purchased by the Signal Corps as standard equipment. Numerous cross-country and endurance records were made with this machine at Army Aviation Field, San Diego, Calif. When the outbreak on the Mexican Border occurred in 1914, repeated orders were given for machines of this type, and the Burgess Company met the situation, which the scarcity of airplanes had caused. It broke every production record of the world by producing the first three machines in complete flying condition twenty-four days after the Government order was telegraphed.

The development of the hydro-aeroplane was, in the meanwhile, being pushed with vigor. The Company produced the Flying Boats K, H and I. These machines embodied an entirely new method of construction in the wings. Steel tube girders were employed in place of wood, and the upper wing was so mounted as to rotate around a fixed forward girder for warping. This girder was placed approximately at the center of pressure of the wing so that

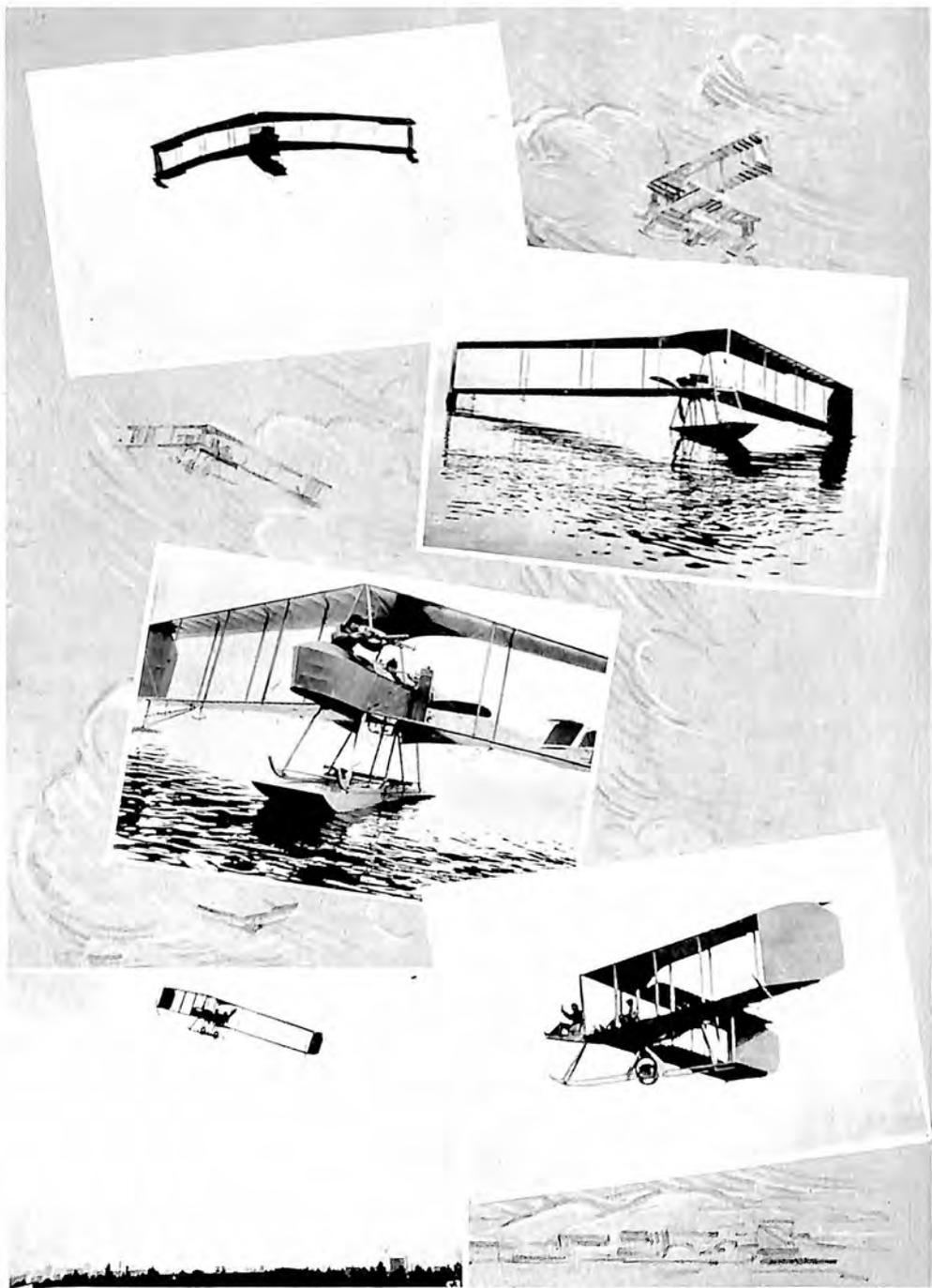
all air forces were balanced and warping was effected with a minimum of effort. This marked the birth of the idea of balance control surfaces, now utilized on all high speed and large-area weight-carrying machines. Model K passes the very severe test then demanded by the Navy Department and was purchased by it. Models H and I were later designs, having the same principles of construction as model K, but using different motive power.

Model I, built under contract for Mr. Robert J. Collier, was driven by a 220 H. P. 20-cylinder Anzani motor, and was at that time the most powerful machine ever constructed in this country. It was flown successfully by the noted Wright aviator and instructor, Frank T. Coffyn.

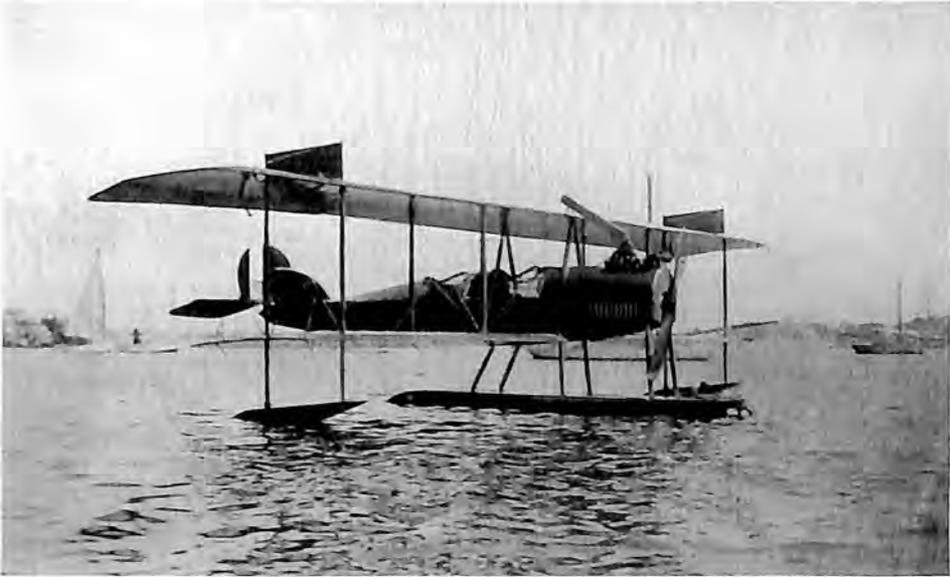
Meanwhile an important adjunct to the sporting type of seaplane appeared when the Burgess Company developed and constructed a special floating hangar fitted with all modern conveniences for the expeditious handling of the machine in addition to complete facilities for making repairs. Living quarters for mechanic and aviator were included. The floating hangar so constructed was used for the entire summer as an addition to the housing facilities of the Burgess flying school and proved its worth in an entirely satisfactory manner. It is expected that the floating hangar is a solution of the difficulties encountered by the sporting aviator in securing proper facilities for the handling of his machine, as it can be towed to any convenient place with its full quota of spare parts, mechanics, etc., ready for duty at any time.



Burgess Pusher Biplane, Manufactured in quantity for the British Admiralty



From top to bottom: 1 and 2—Burgess-Dunne Sporting Type Seaplane; 3—Burgess-Dunne Type, with Rapid Fire Gun; 4—Burgess-Dunne Land Machine, showing pilot, with locked levers, flying "hands-off"; 5—Burgess-Dunne Type Aeroplane, built for United States Signal Corps.



Burgess Model U-2 used by Navy at Eastern Flying Stations. Note transparent section around seats

No machine can fly without stability. A certain amount of stability has been imparted to all machines, so that now the problem of stabilizing a machine is not one which receives much consideration. But six years ago it was the poser before which all designers and aeronauts stood doubtful and irresolute. A severe gust of wind, a bad "hole in the air," and the average machine was apt to lose its balance, perhaps plunge its occupant downward to injury or death. Certain features, however, had been making for a tendency toward stability in all machines, and an English Officer, Lieutenant Dunne, had accentuated these to the point where the machine, instead of being easily upset, would hold its proper position, or even return to it if put into an abnormal one.

He employed an entirely different system of control and balance from that used on any other type of aeroplane and secured basic patents thereon. The Dunne plane, unlike the Curtiss and Wright models, has no tail, no fuselage in the usual sense of the term. It is steered and given lateral and longitudinal balance by one set of ailerons. Burgess developed the machine until he had produced a plane which, with two people and heavy pontoons, excelled in performance the original single place Dunne design. It flew faster and climbed faster than any other seaplane of its size.

In 1913, the Burgess Company secured American patent rights to



Burgess Scout B, selected by the Navy for production in 1917

manufacture machines under the Dunne patents covering inherent stability. The first machine built under these patents was tested in February, 1914, with immediate success. It was an adaptation to marine flying of the early machine built by Lieutenant Dunne in England for land usage, and was the first instance in which pontoons had been successfully applied to an inherently stable machine.

The salient features of the Dunne include a sweep-back of the wings at approximately thirty degrees, and the entire elimination of all auxiliary controlling surfaces. The swept-back portion of the wings is characterized by a gradually decreasing angle of incidence and by vertical fixed end panels which are placed at the extreme wing tips. The combination of these features produces perfect inherent stability longitudinally and laterally in any kind of weather, as fully described in Dunne patents and borne out by the experience of the Burgess Company.

The first Dunne machine was a hydro-aeroplane with single square flat-bottomed pontoon and wing tip floats and Curtiss 90 H. P. motor pusher installation. This machine included the so-called "Bustle" specified by the inventor as essential to secure the best results.

The principles of inherent stability embodied in the Dunne patents were proven to be sound and a number of remarkable flights, demonstrating this quality, were made with this model before representa-



A later development of the Tractor Side-by-Side Seating Arrangement

tives of both branches of the United States Government and committees of various aviation enterprises.

It was conclusively demonstrated, for instance, that it was possible with this machine to fly long distances with locked control levers. It was shown that it was possible for the aviator to draw maps or otherwise occupy himself, leaving the machine to take care of itself by its automatically inherent features, or to allow it to approach a stalled condition and then release the controls and let the "ship" bring into play its ability to remove itself automatically from an ordinarily dangerous position. It was demonstrated that it was equally feasible to lock the controls while the machine was at rest on the surface of the water in a position correct for moderate climbing rate, then to throw on the power and allow the hydro-aeroplane to leave the water and climb to a considerable height before again touching the levers. Another possibility exhibited was that of setting the levers for a steep "bank" and allowing the machine to make three complete circles banked at forty-five degrees or more without the controls being once touched.

The above demonstrations attracted immediate attention from the Army and Navy with the result that a number of machines were produced for the military uses of United States and Canadian Governments. During the years from 1914 to 1916 a great variety of Dunne type machines was produced by this company, all of which



One of the Pontoon Shops at Plant 1, Burgess Company

had the inherent stability features. The types included side by side training; side by side observation; tandem seating training and observation; weight carrying seaplane; machines adapted to use of rapid-fire gun; flying boats; sporting type; special radio equipped type for Signal Corps; special design for Russian and Italian governments.

Motors utilized included Curtiss OX, 90 H. P.; OXX, 100 and 110 H. P.; Curtiss VX, 180 H. P.; Sturtevant 140 H. P., Salmson 120 H. P. and Hispano-Suiza, 150 H. P.

By this time war had come upon Europe like a sudden storm. With the beginning of hostilities, a commission of British experts hurried to America. They wanted aeroplanes—many of them. They wanted them soon.

This latter stipulation was a difficult one for most American manufacturers. But the Burgess Company designed, built and tested an experimental pusher biplane in exactly twenty-one days, which was at the time admitted by the British experts to be a phenomenal record. A Burgess Seaplane was sold to the Canadian Government on September 14th. The machine speedily passed acceptance tests without a hitch and a number were ordered for quick delivery over-seas. Inside of two weeks after completion of experimental machine, a production of three per week was attained and maintained during the entire run of the order. This machine was the first fight-



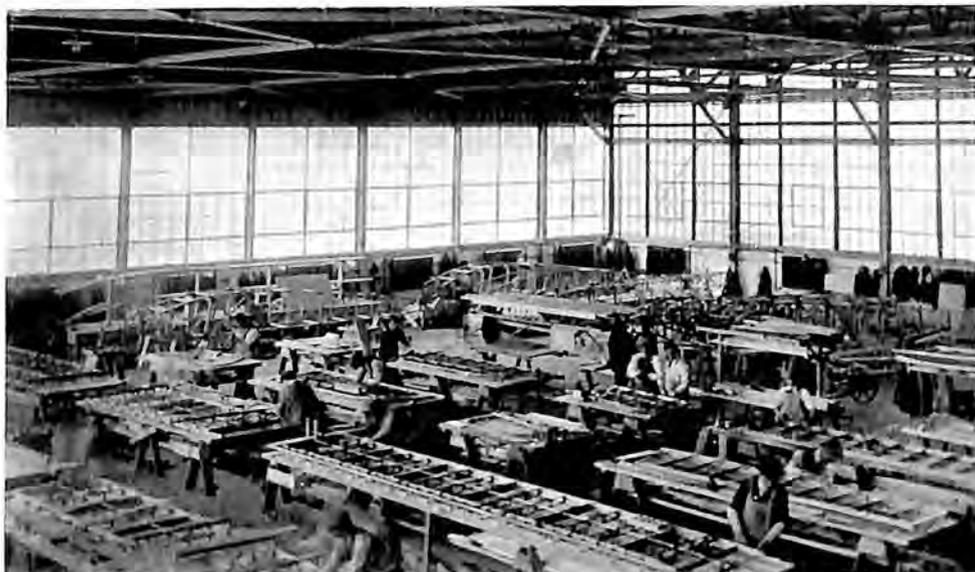
A corner of the Fuselage Assembly Room, Plant 2

ing plane built in America and shipped to Europe for the recent war.

These machines were used for advanced training and for military observation, and were designed for a speed of eighty-five miles per hour, with four hours' radius of action.

The American Navy was now being rapidly enlarged in accordance with the Government's change of view during 1915. In 1916, the Burgess Company completed designs for preliminary tractor trainers, in accordance with the Navy Department's specifications. These machines were required to have a factor of safety of eight throughout. The Model S Hydro-tractor was the new Burgess machine. It met the severe tests imposed by the Government specifications. It was a tandem-seating tractor type driven by a Hall-Scott six-cylinder 120 H. P. motor. It proved especially rugged in withstanding the hard knocks given by student aviators.

Nor did the naval work of the Company stop here. Numerous inquiries at this time from State Naval Militia organizations for an improved tractor training machine resulted in the design of the type U, which was a modification of Model S. A single float was substituted for twin-floats and Curtiss OXX motor in place of Hall-Scott. Numerous refinements of detail resulted in a considerable saving of weight and made the U the most efficient all-round machine for Naval training produced at that time.



Another view of the Fuselage Assembly Room

Indeed, during its use at one of the principal flying stations in the East it proved so successful that an order was given for considerable number of similar machines embodying only slight modifications. The Burgess type U-2 was the result, and was the most highly developed type of machine that had ever been produced up to that time. The greatest attention was paid to details regarding comfort of pilot and pupil; arrangement of instruments, controls and accessories; simplicity of construction and elimination of all non-essential parts; ease of assembly, disassembly, and repair.

Early in 1917, specifications were issued by the Navy for a hydroplane scout capable of a speed of 90 miles per hour with 100 H. P. motor. Two designs, known as Scout A and Scout B were worked up and Scout B was selected as the most desirable type to put into production. This machine embodied absolutely unique principles of construction and is worthy of special note. By an original method in design, a great number of struts and wires, ordinarily regarded as necessary, were eliminated, the designers thus cutting down resistance to the least possible amount consistent with the strength. A patented spring shock-absorber was incorporated in the pontoon construction, which resulted in a degree of smoothness in landing and getting away, never thought possible in a machine having a wing loading of over nine pounds per square foot.

The Burgess Company, early in 1917, realizing the future possi-

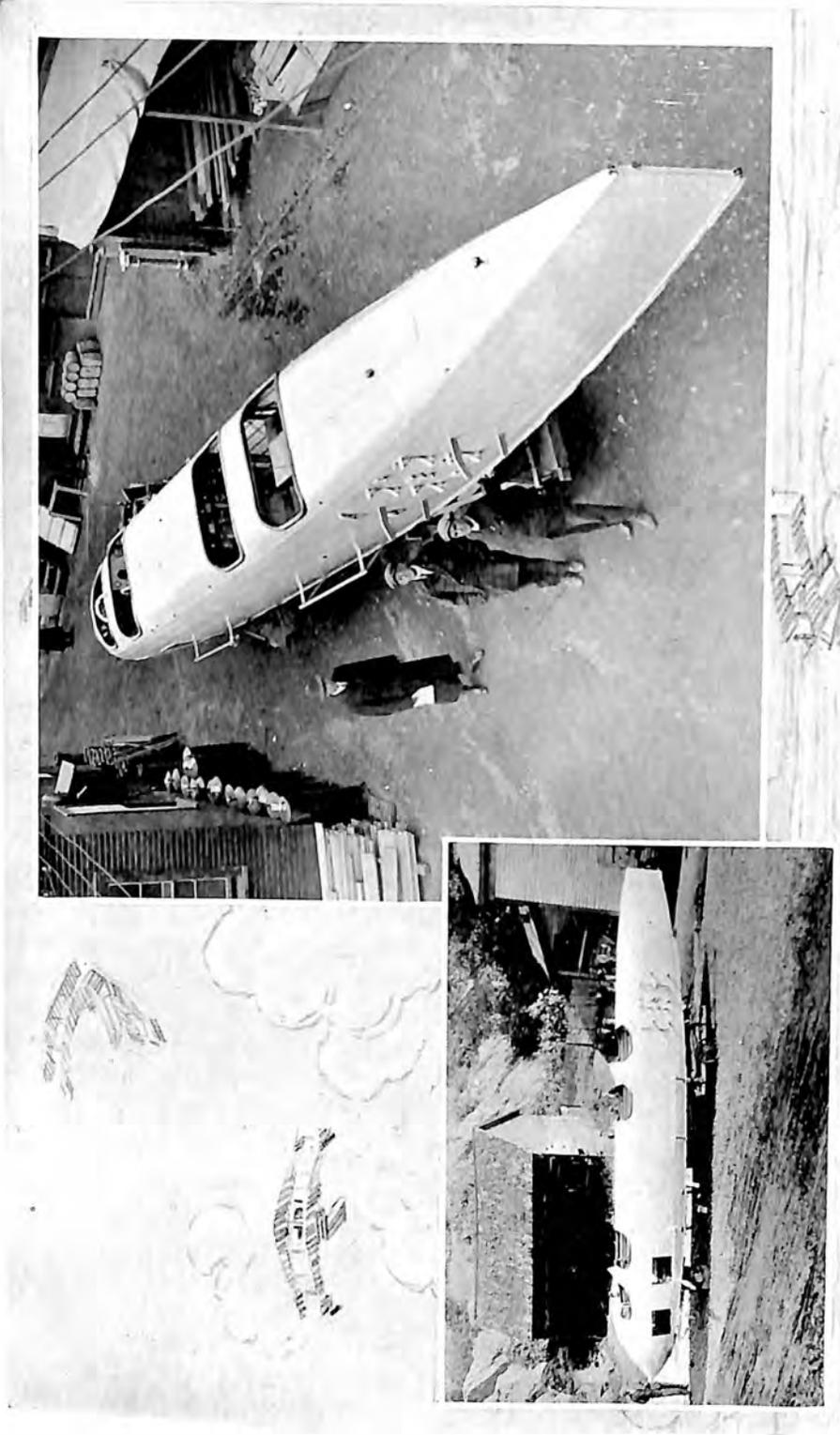
bilities in the aviation industry, had constructed their Plant No. 2, which provided immensely enlarged facilities for quantity production of highest quality. Hence, at the entry of the United States into the world war, the company was fully equipped to undertake production of any type of machine from the smallest scout up to the largest air cruiser.

The Government soon had work for it to do. After an exhaustive study of the facilities of the various factories throughout the country, the Burgess Company was selected by the Navy Department to build training seaplanes. The entire manufacturing facilities of the company were immediately brought into play in the production of N-9 seaplanes, which were later changed to N-9-H, the difference being in the motor installation.

A short time after getting underway, the production of one machine a day was reached and was gradually increased until a production of four per day, in addition to spares, was attained. This, with a floor space of only 50,000 square feet and the employment of a maximum of eleven hundred men and women, is a record never approached in any other factory.

The N-9-H machine, fitted with Hispano-Suiza motor, is now acknowledged to be the best from every standpoint that has ever been used by the Navy Department for training. In addition to being used for elementary training, it has served to a considerable extent as a machine for preliminary training in gunfire.

A new development in Burgess construction begun with the summer of 1918. The airship equipment of the Navy had become one of growing importance. The Burgess Company undertook to build for the Government a number of large twin-engined dirigible cars, and fortunately its complete organization for experimental development especially fitted the Company for this work. The completed cars have given excellent service. The dirigible car which the Burgess Company designed mounts two 150 H. P. Hispano-Suiza motors on outriggers. It carries bomb racks with launching mechanism, radio apparatus and the most complete equipment of accessories and instruments ever mounted on any aerial craft. This includes fuel and oil for ten hours, water ballast and gauges, gas pressure nanometers, barometers, air speed indicators, banking indicators, compasses, bomb-sighting apparatus, electrical starting and generating equipment, mufflers, dash board and running lights, and every instrument necessary for the proper recording and supervision of the operation of the two motors.



Two views of twin-engined dirigible cars of Burgess construction



Model K, Burgess Flying Boat

These machines are to be used for coast defense and offensive against submarine attacks. Recent flights over Washington and eastern cities have attracted universal attention; several long distance flights already having been made from middle western cities to the eastern coast.

The recent discovery of a process by which non-inflammable helium can be produced economically will doubtless give a great impetus to the building of airships, both for Government and for private commercial use. The airship, indeed, gives promise of being the aerial craft which will be used almost exclusively for voyages of 1,000 miles and more. The Burgess Company is, consequently, in an excellent position to meet one of the largest demands of a rapidly growing aircraft business. Its equipment for the manufacture of dirigible cars, together with its long experience and achievement in the production of sea aircraft, put it in a promising position with respect to future aerial development.

PRESIDENT RUSSELL, A PIONEER

It was the whirr of more than wings which drew Frank H. Russell to his office window one autumn day in 1909. Wilbur Wright was flying from Governor's Island to Grant's Tomb in connection with the Hudson-Fulton celebration, and his humming engine it was which caused the president of the Hook and Eye Com-

pany of Hoboken to look upwards and outward over the West River.

What he saw influenced Frank H. Russell profoundly. He felt an active interest in airplanes. And it was not long before he had managed, with the assistance of his cousin, Russell A. Alger, to meet Wilbur Wright. The meeting led to a connection on Mr. Russell's part with the Wright Brothers. He became in 1910 their first general manager—the first general manager, by the way, of an airplane company in America.

Mr. Russell had taken his A. B. from Yale in 1900, travelled a year in Europe, and served as sales manager for a newspaper manufacturing company in Canada until 1905, acting as United States Consul during the period. At thirty-one he was able to bring a varied experience, as well as an ample enthusiasm to his new and unprecedented position.

Service with the Wright Brothers was a step toward an interest in a company more his own. In November, 1911, Mr. Russell associated with Greely H. Curtis and W. Starling Burgess, became general manager of the Burgess Company and Curtis. In 1917 he became president of the Burgess Company. When the company was allied to the Curtiss Aeroplane and Motor Corporation he retained his interest in the Marblehead factory and became a director of the Curtiss Corporation. Soon, however, he shifted the emphasis of his work to the Curtiss Engineering Corporation as its vice-president and general manager.

When the Manufacturers' Aircraft Association was organized on July 24, 1917, Mr. Russell was chosen its president. He has had no small part in the rapid development of the Association.

Son of an Ohio clergyman, Mr. Russell has a keen sense of duty and a firm belief in the effectiveness of the golden rule with respect to his employees. But he also knows how to be human. He knows his men as fellow-workers, and he makes them feel that work, while it is something to be done and done expeditiously and well, is, after all, a game—the best game that the world affords. Perhaps his success is simply a happy transfer of his own experience. Next to flying he loves nothing better than to lean the sail of a fast yacht into a steady wind and feel the whistle of air and spray and the play of sunlight on canvas and on water. But he also loves nothing better than to supervise the production of airplanes. He has been able to make those associated with him feel that the two—called play and work—are equally enjoyable, are essentially the same. And this is one of the secrets of his success.



Navy, Curtiss and Army Executive Offices at North Elmwood Plant

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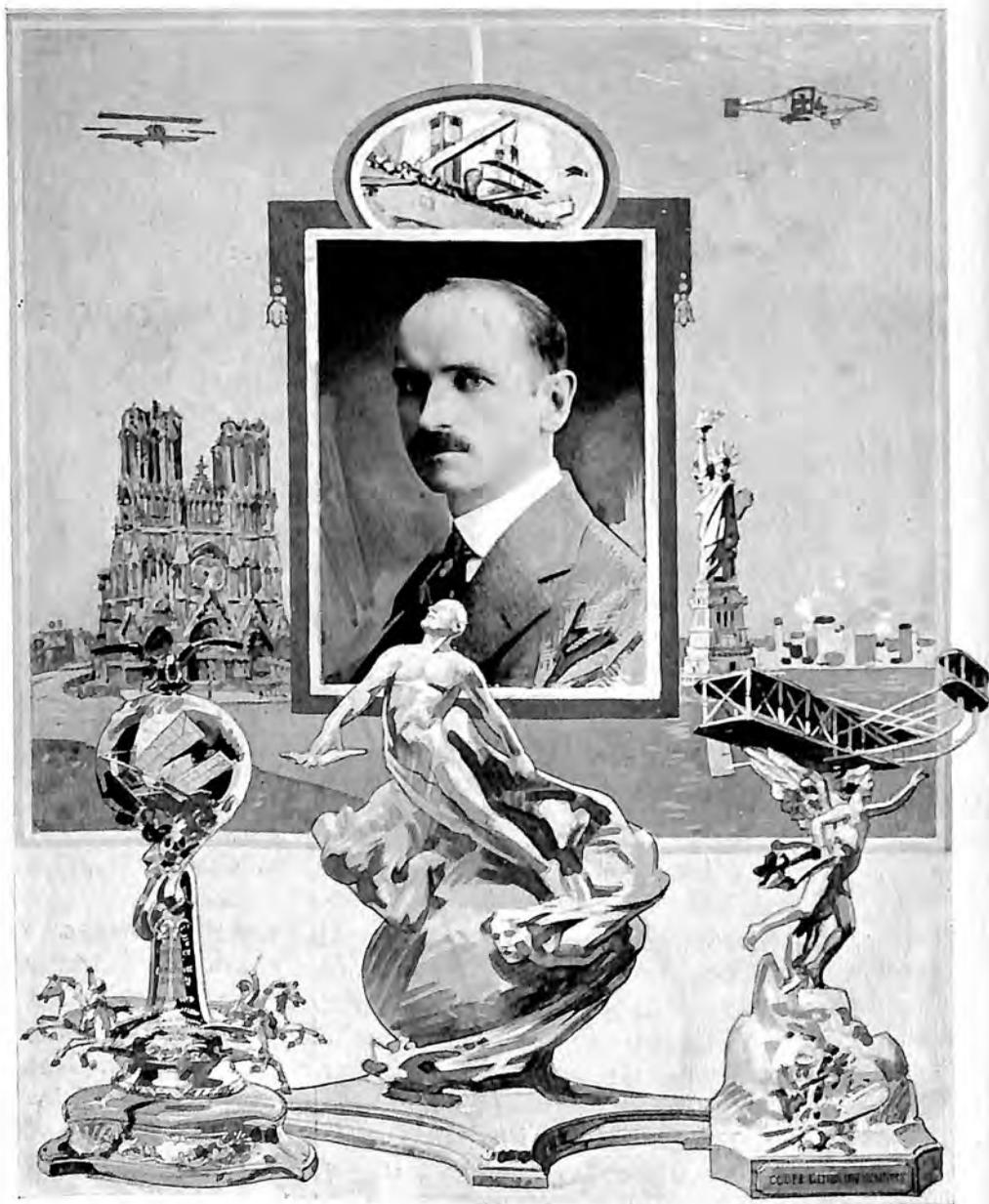
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J. E. KEPPERLEY	W. W. MOSS	C. B. WILSON	

PLANTS—Buffalo, Hammondsport, Garden City, L. I., and Marblehead.

FLYING FIELDS—Buffalo, Newport News, Va., Miami, Fla., Garden City, Port Washington, Marblehead and Atlantic City.

TO go back to the beginning of anything significant is always to get a thrill, for significant things grow quietly, and one is never aware of them until they are imposingly mature. It is said that 95 per cent of the men whom Uncle Sam has taught to fly have touched the controls of a Curtiss flying boat or a Curtiss JN-4. But the usual Air Service man assumes that the Hammondsport-Buffalo-Long Island combination of nine plants and four flying fields has always existed. It never occurs to him that the Curtiss Aeroplane and Motor Corporation had a beginning. Yet, if he could fly a JN-4 back to its ultimate infancy, it would land him in a bicycle shop!

It would land him in a bicycle shop, however, which was soon to change to a motorcycle factory. And the proprietor of twenty-two who in 1900 tinkered with tomato cans in his "industrial incubator" was to develop gas engines of remarkable power and lightness. With these he was not only to drive motorcycles and himself ride his



GLENN H. CURTISS

Pioneer aviator; founder of the Curtiss Companies; some of his early achievements and the trophies he has won

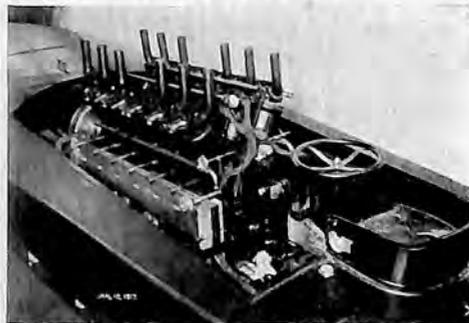


Curtiss and Machine used in Albany-New York flight

machines in record-making time, but he was also to attract men who wanted his product for experiments in flying. In 1904 he had already furnished the power plant for the "California Arrow," Captain Baldwin's dirigible balloon. In 1905 one of his motors drove the airship which Captain Baldwin sold the Government. In 1907 Mr. Curtiss was working with Dr. Alexander Graham Bell in various aerial experiments, and on March 12, 1908, one of his engines propelled the "Red Wing" for 318 feet and 11 inches through the air above the ice of Lake Keuka, near Hammondsport, New York. "This," says Dr. Bell, "was the first public exhibition of a heavier-than-air machine in America."

The "Red Wing" was a product of the "Aerial Experiment Association," but it marked the beginning of Mr. Curtiss's aeroplane experience, and must be thought of as in a sense a forerunner of the factory at Hammondsport—as the impetus which was to express itself eventually in the production of thousands of planes for the United States and her allies in their trans-Atlantic struggle. The first machine built under Mr. Curtiss's direction, however, was the "June Bug," the third produced by the Association. In this the young-engine builder won, on July 4, 1908, the *Scientific American* trophy offered for the first public flight of one kilometer ($\frac{5}{8}$ miles).

This was the beginning of a series of brilliant performances by Mr. Curtiss as inventor and aviator. The Aeronautical Society of New York City was emboldened



Curtiss Aeronautical Motor V-4 installed in speed boat Miss Miami



JOHN NORTH WILLYS
President, The Curtiss Aeroplane and Motor Corporation



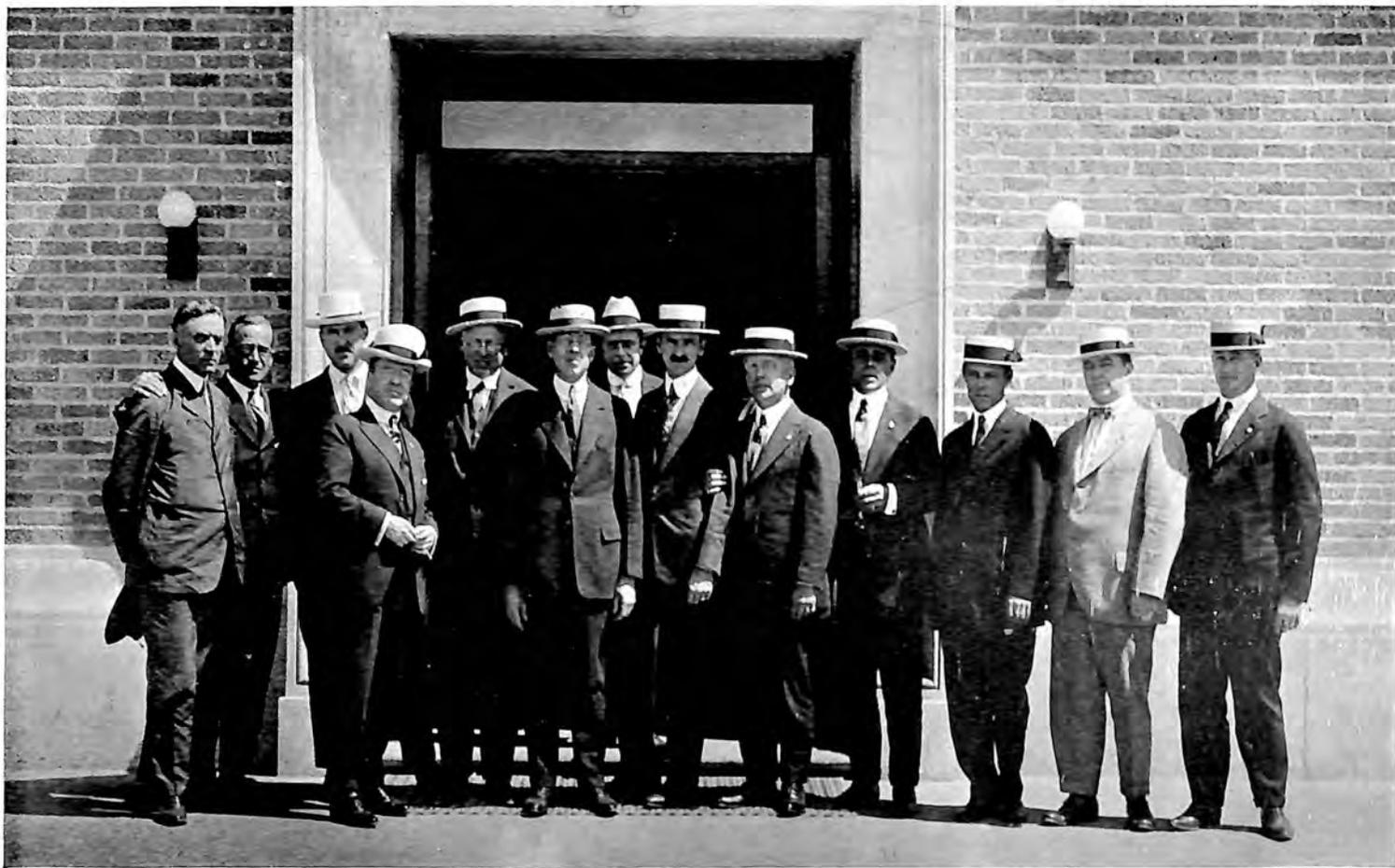
Langley Machine flying over Lake Keuka, N. Y.

to give the winner of the *Scientific American* trophy an order for an aeroplane. The factory at Hammondsport was enlarged, the machine built, and on June 26, 1909, Mr. Curtiss piloted it in the first aeroplane flight in New York City. Three weeks later he won the *Scientific American* trophy a second time, flying for three-quarters of an hour and covering a distance of 24.7 miles. On the 29th of August, he won the speed test at Rheims, France, beating the Frenchman Bleriot by six seconds over a twenty-kilometer course. He had travelled at the rate of 46.5 miles an hour.

The machine, which had now become known as the "Curtiss," was a comparatively small biplane with a wing spread of 26.42 feet, a chord of 4.5 feet, and a total supporting surface of 212 square feet. It had an "elevation rudder" which was composed of two planes set in front of the wings on bamboo outrigging. The rudder proper and the horizontal stabilizers were mounted to the rear in the same general fashion. The 25 H. P., 4-cylinder motor (later an 8-cylinder 50 H. P. engine was used) turned a two-blade propeller at 1200 R. P. M. The machine was a pusher type. The pilot sat in front entirely exposed to the rush of air, and, as the foregoing description indicates, there was no effort to enclose engine or substitute a streamlined fuselage for outrigging in an effort to cut down resistance. Lateral control was by two interplane ailerons.

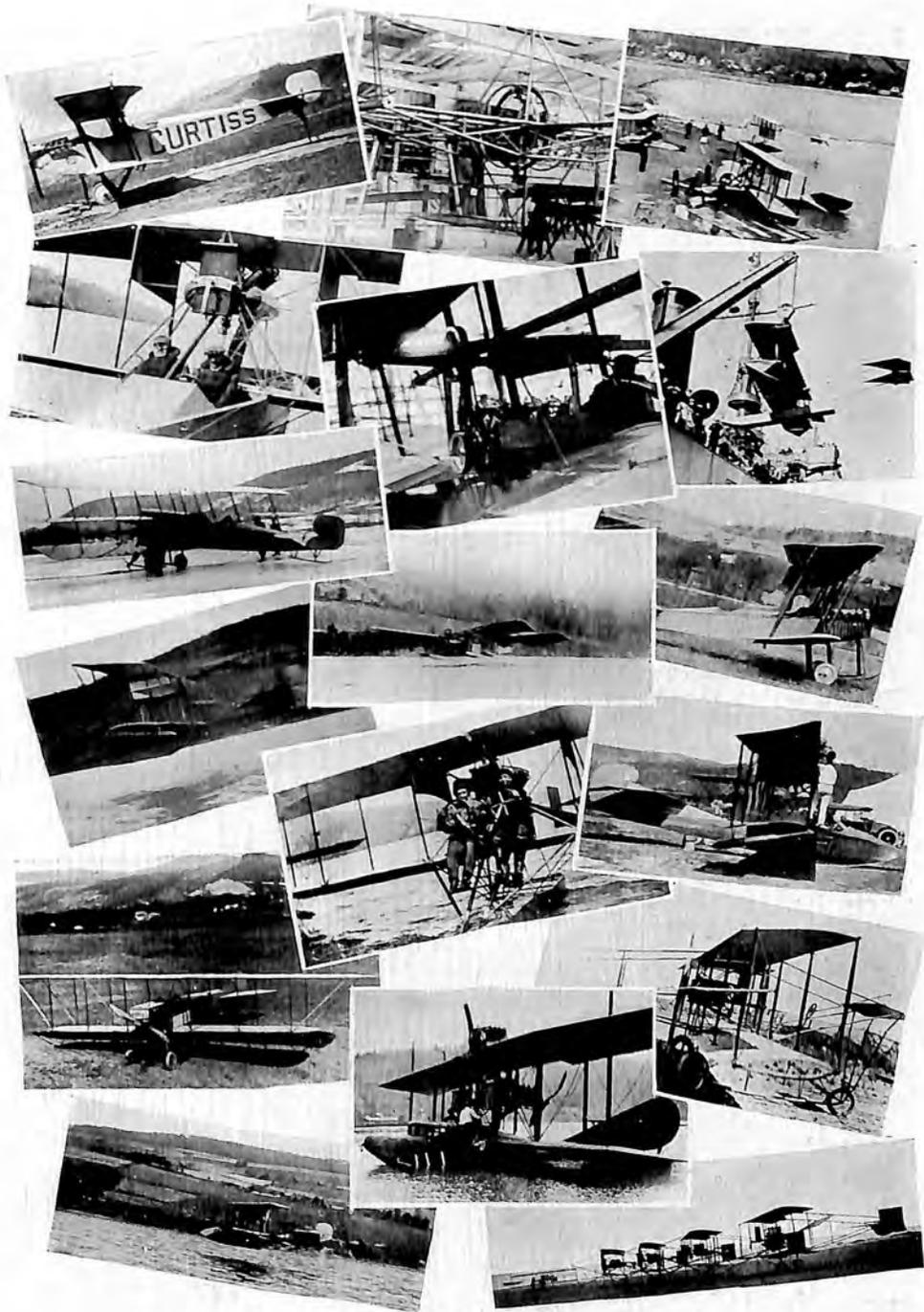


Curtiss "Autoplane"



CURTISS DIRECTORS AND EXECUTIVES AT GARDEN CITY PLANT

From left to right: W. W. MOSS, F. H. RUSSELL, C. B. KIRKHAM, J. ALLAN SMITH, HARRY EVERS, JAMES E. KEPPERLEY, J. W. FORSE, GLENN H. CURTISS, JOHN N. WILLYS, A. H. MARKE, C. M. KEYS, W. B. STRATTON, W. L. GILMORE



Early Curtiss Models



AEROPLANE PHOTOGRAPH OF THE CURTIS
The Largest Aeroplane Manufactory



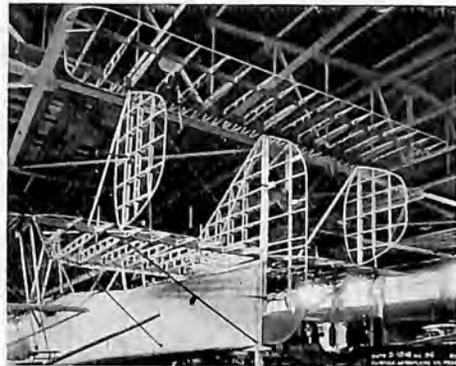
NORTH ELMWOOD FACTORY AT BUFFALO
Manufacturing Plant in the World



Curtiss Model HS-2-L Flying Boat

With this type of machine Mr. Curtiss attempted and made his remarkable flight from Albany to New York, winning the *New York World's* \$10,000 prize. It was an achievement which marked the beginning of practical aviation, a more difficult feat than Bleriot's crossing of the English Channel, as the American journey lasted for "one hundred fifty-two miles over a broad, swift stream, flowing between high hills or rugged mountains the entire distance and with seldom a place to land; it meant a fight against treacherous and varying wind currents rushing out unawares through clefts in the mountains, and possible motor trouble that would land both machine and aviator in the water with not much chance of escape from drowning, even if uninjured, in alighting." It was successfully accomplished in four hours and fifty-eight minutes, with two landings during the course of the trip. The outstanding feature of this flight was the continuous use of a river as an aerial guide.

This was the last exhibition trip which Mr. Curtiss essayed, though he was by no means through with his work as a pilot. He was a veteran now, though only thirty-two, and could watch those whom he had taught to fly carry the Curtiss machines through tests of daring, speed and endurance. When he delivered a machine to the Aeronautical Society of New York City in the summer of 1909, he undertook the instruction of two student aviators, Mr. Charles F. Willard and Mr. Williams. Since that time innumerable graduates of the Curtiss schools (there have been training fields



Tail Construction, Model T Flying Boat



Curtiss Model F Flying Boat

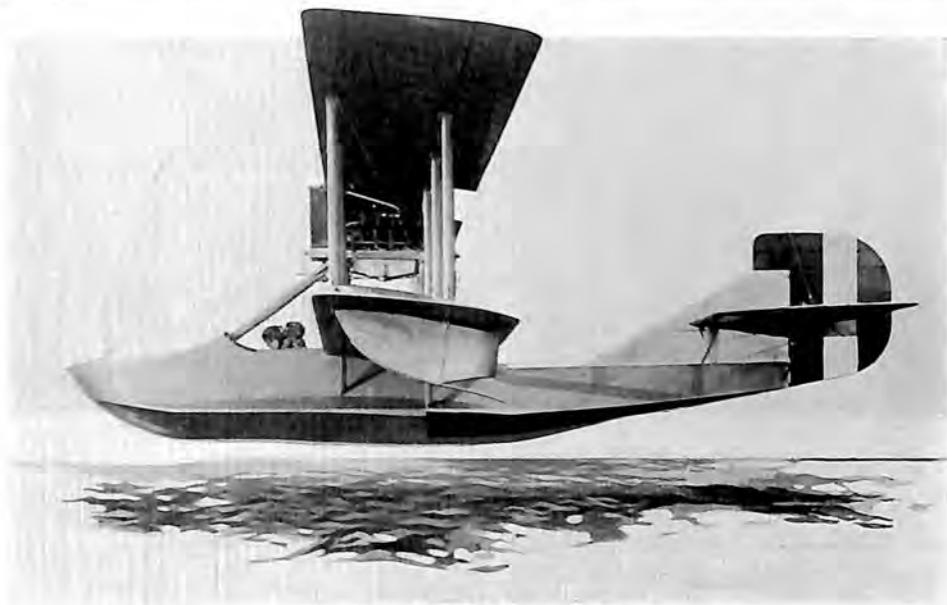
at Hammondsport; San Diego, Cal.; Miami, Fla.; Newport News, Va. and Buffalo, N. Y.) have put their names on the lips of men by unique or persevering performances. J. A. D. McCurdy was the first pilot to send and receive a wireless message. Charles K. Hamilton flew a Curtiss machine in the Gordon Bennett Aviation Cup Race in 1910. Eugene B. Ely, on January 18, 1911, flew out to the battleship *Pennsylvania*, landed on her deck, took off and returned to shore. Lincoln Beachey flew under the Niagara Bridge in June, 1911, and on August 20th made a world's altitude record of 11,642 feet. Lieutenants T. J. Ellyson and J. H. Towers were Curtiss students, and the first navy officers to fly over water together. In October, 1911, they flew from Annapolis, Maryland, for forty-three miles to Buchroe Beach, Virginia.

But while the Curtiss machines and Curtiss students were performing so consistently and remarkably, the developer of the aviation motor and the effective aeroplane which bore his name had turned his attention to a new phase of aeronautics.

Mr. Curtiss had had an "amphibious" machine in mind "ever since the first experiments in Hammondsport." He kept thinking on the hydroaeroplane question. When he made his Albany-New York flight it was with a land machine which was equipped with attachments for landing on water. And during



Early Model F Flying Boat



Curtiss Model MF Flying Boat

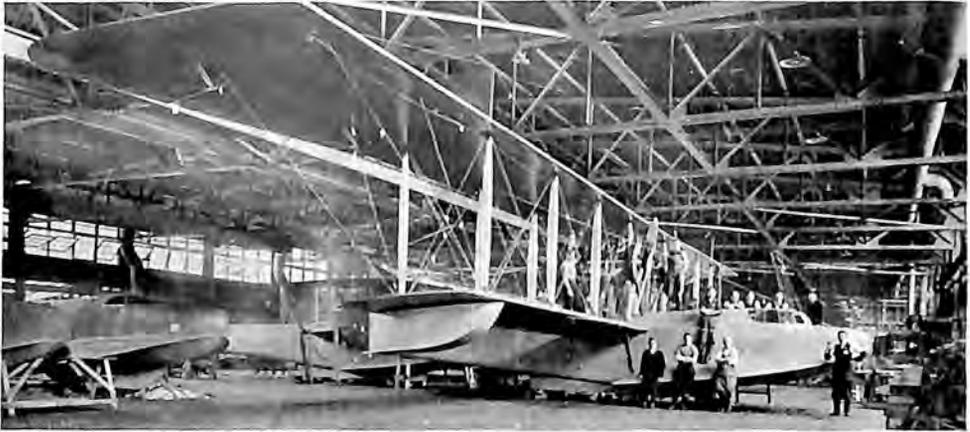
the trip he decided to build a successful hydro-aeroplane. He even planned the transition from pontoons to flying boat.

It is impossible to follow in detail the successful work at North Island, San Diego, where Mr. Curtiss developed both the hydro-aeroplane and the flying boat. Here Mr. Curtiss ultimately successfully rose from the water and made a sustained and controlled flight. On February 17th, the new hydroaeroplane flew out to the U. S. S. *Pennsylvania*, was hoisted aboard, swung back into the water, and returned safely to land. In April, the United States adopted the new craft. With it Mr. Curtiss was able to return to the Government a squad of young naval officers whom he had taught the art of flying, land and marine!

The developments of these early years had established Curtiss motors, Curtiss aeroplanes, Curtiss hydroaeroplanes and Flying Boats in a coveted and secure position. The day of prizes was almost past. The Curtiss Aeroplane Company and the Curtiss Motor Company had always existed on a paying basis.



Pioneers in Aviation in Front of Early Curtiss Flying Boat



Curtiss Model H-12-A Flying Boat on erection floor, Churchill Plant

They now began to develop with the first genuine leafing of the new industry. Flying boats were built and sold regularly. The OX and VX motors were developed. The Curtiss aeroplane shed its interplane ailerons, its front elevators. It acquired an enclosed fuselage, controlling surfaces set at the tail and ailerons hinged in the wings. This was the course of development which led to the JN-type. The construction was now basic, and subsequent improvements were generally in answer to the demand for speed.

When the European War began, the Curtiss Aeroplane Company had indeed developed its threefold activity of building motors, airplanes, and flying boats. Realizing the need of immediate action a British mission was sent to America to purchase training planes for her aviators. Planes demonstrated by Curtiss fliers proved their stability in rough weather conditions, unusual safeness and ease of control to the members of this commission, and the JN-4 model was selected and orders placed. Within a month after Germany had begun her drive on France, the little Hammondsport factory was humming. It was soon evident that the plant must be enlarged, to cope with the increased schedule.



Sand Load Test of H-12-A Panels

Mr. Curtiss, finally, decided that Buffalo offered definite advantages as a supply and shipping port, and he soon leased there a considerable portion of the Thomas Power Building, which seemed



Curtiss Model H-16 Flying Boat

large enough for all projected extensions. But the simultaneous arrival of Spanish and British orders changed the outlook. More space, in addition to the new plant, was obviously a condition to the acceptance of these contracts. On March 10, 1915, under the management of K. B. MacDonald, the "Churchill" plant was begun. It was completed in thirty days, furnishing additional 110,000 square feet area. On May 10th this plant was putting through its first machines. The output of this plant has steadily increased, until ultimately over 100 per week were shipped.

The increased demand for motors made further expansion necessary, and the Century Telephone building in Buffalo was taken over and operated as the South "Elmwood" plant.

Upon receipt of further orders, the Curtiss company was encouraged to increase its facilities to meet these demands.

On January 13, 1916, the Curtiss Aeroplane and Motor Corporation was incorporated, taking over the Curtiss Aeroplane Company and the Curtiss Motor Company.

A month later, it acquired the stock of the Burgess Company at Marblehead, Mass., and controlled the Curtiss Aeroplane and Motors, Ltd., of Canada, the Curtiss Exhibition Company, which was operating the flying fields and schools at Buffalo, Hammondsport, Miami, San Diego and the Atlantic Coast Aeronautical Station, Newport News. Plants were in operation at Buffalo, Hammondsport, Toronto and Marblehead.

The decision of the United States to enter the war was accompanied by an increasing pressure for aeroplanes for the training



Live Load Test H-12-A Panels



New York-Chicago Times Flight Machine. Model R-4 and Speed Scout Model S-3

of American aviators, and this, together with the steady demand from foreign governments, made further expansion necessary.

With the large expansion of Curtiss industries, Mr. Curtiss found himself less and less able to devote his time and energies to the phase of the work in which he was most vitally interested—the designing end.

He succeeded in interesting John N. Willys in his plan for a combination of interests, and early in 1918, an arrangement was effected whereby there was linked together the powerful command of markets for raw materials and the enormous production facilities which Mr. Willys commanded and the inventive and development ability which Mr. Curtiss possessed.

The change was made in June, 1917, just as the Corporation began its war work for the Government. Mr. Curtiss from that time on turned more and more of his attention to the creative work being carried on by the Curtiss Engineering Corporation, which was built later.

Mr. Willys, by reason of his success in the development of markets, and appreciation of standardized production, was a national figure in finance and industry. Beginning as a manufacturer of bicycles, he entered the automobile field when that conveyance was still in its experimental stage. It was he who had first conceived the idea of reaching markets for manufacturers who were unable to reach them on their own initiative—an idea, the success of which has been



Curtiss Model R-1 Tractor



Curtiss Model Twin JN Land Tractor

borne out by the marvelous expansion of the Overland business which he controls.

On July 28, 1917, W. A. Morgan, then general manager of the Curtiss Aeroplane and Motor Corporation, signed a contract for the erection of what is known as the North Elmwood plant in Buffalo. In exactly ninety days this enormous plant, costing \$4,000,000 and covering 72 acres, with buildings with 31 acres of floor space all under a single roof, was completed and under operation. This is the largest aeroplane manufacturing establishment in the world.

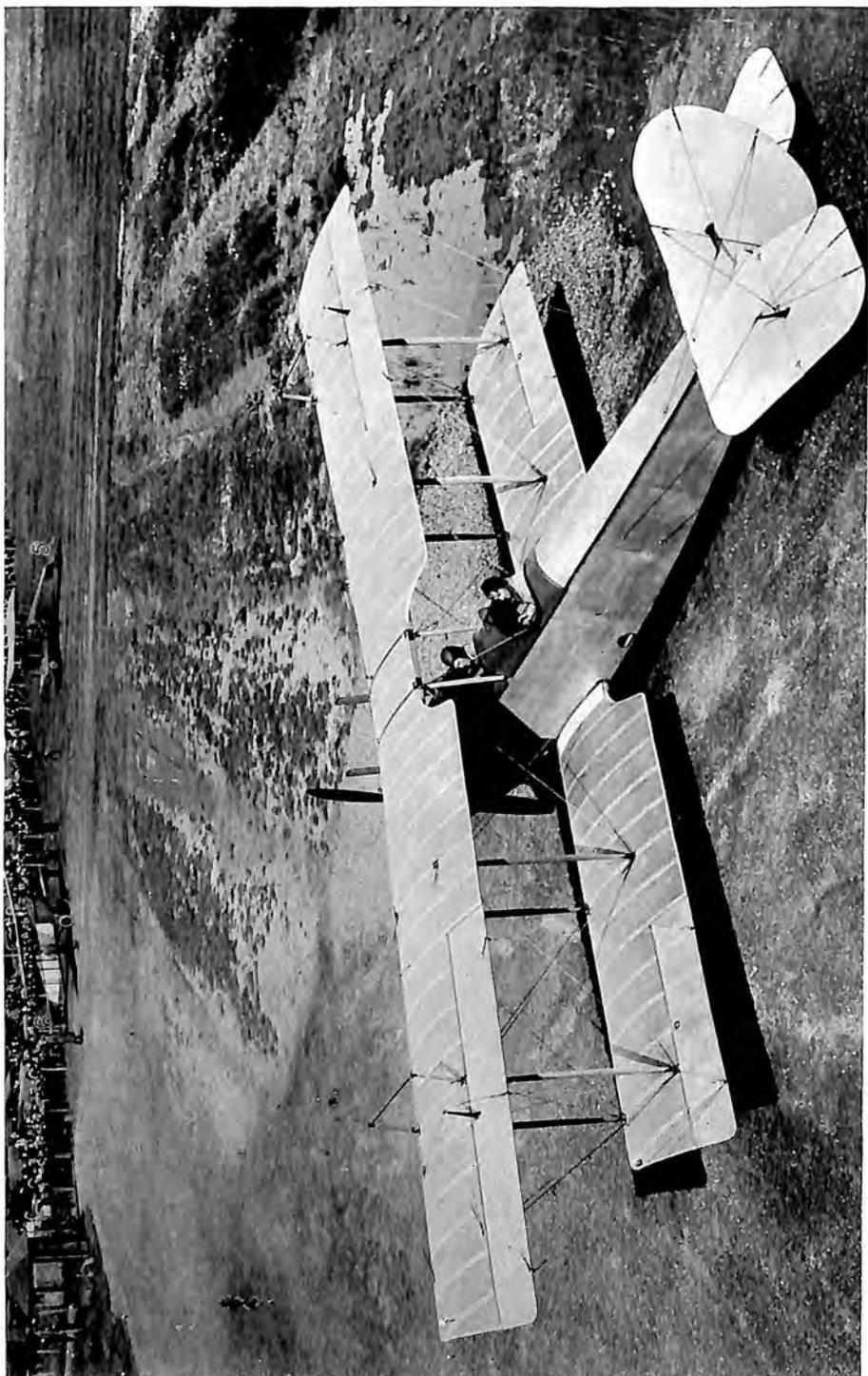
Two other plants had also been taken over—the Austin Street plant and the Bradley Street plant.

Desiring a central place where all experimental work could be carried out, Mr. Curtiss decided to build a separate plant for this purpose. After careful study, it was concluded that Long Island, with its eighteen fields and its numerous flying boat harbors, offered the best facilities. A site was selected at Garden City, where the experimental buildings were erected. This plant is devoted largely to the manufacture of experimental machines. Here have been brought together the corps of research engineers; here have been constructed the model shop and the largest wind tunnel in America. It is at this plant that the latest Curtiss achievements have been thought out and developed.

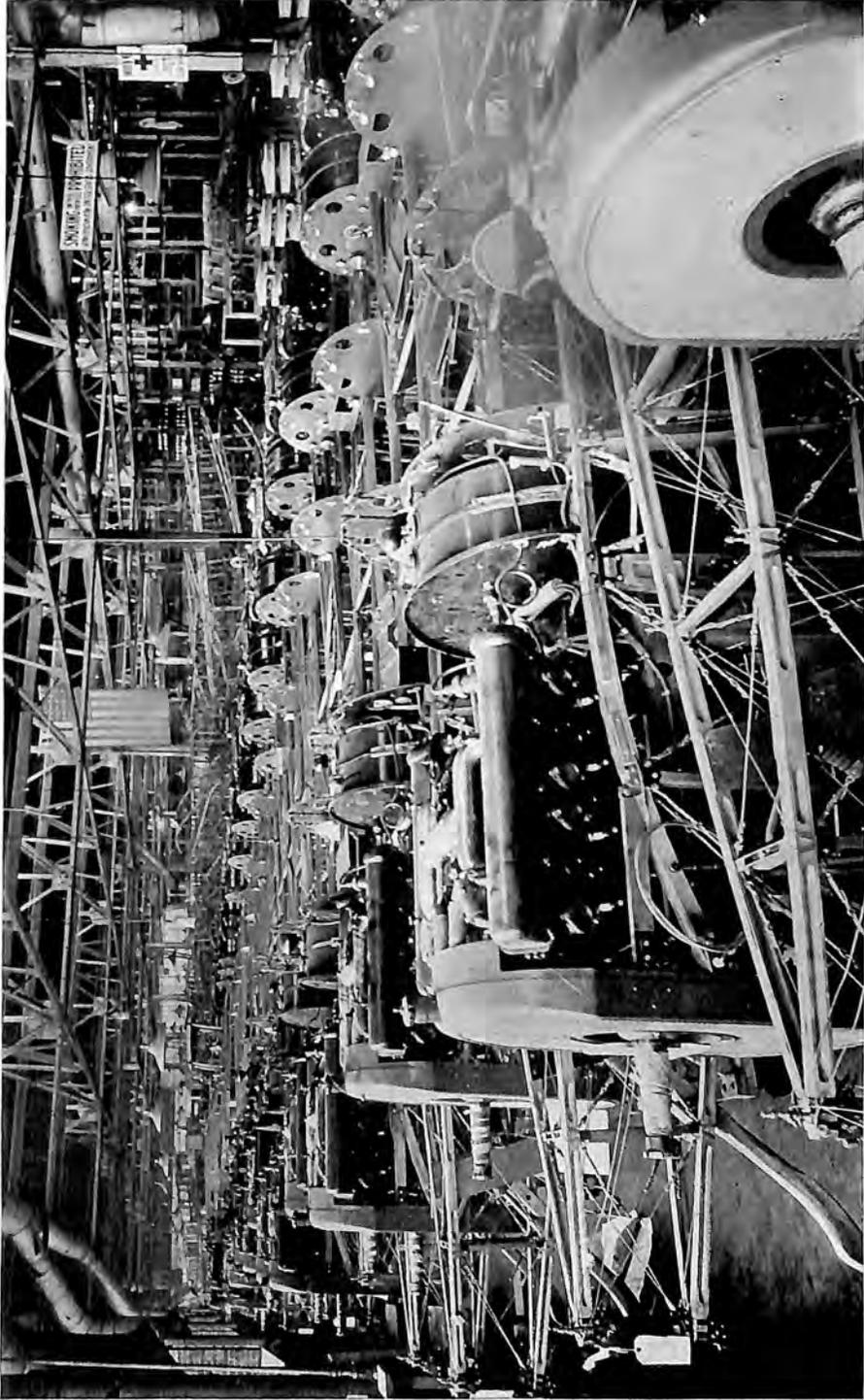
The experimental work and the work of production itself is in especially good hands. The corps of Curtiss engineers included Charles M. Manly, the associate of Professor Langley in his efforts to build a heavier-



Model Twin JN, R-4, and S-3



The famous Curtiss Model JN-4-D Training Plane



One of the Assembly Floors of the Curtiss Churchill Plant



Curtiss Model HA Land Tractor

than-air machine to carry human passengers. Mr. Manly was responsible for the engine of the Langley "aerodrome." He had also acted as pilot in the two unsuccessful attempts made in 1904 to launch it from a house boat on the Potomac. He always believed it capable of flight. He happened to discuss its possibilities with Mr. Curtiss. "Bring it up to Keuka and we'll fly it," said the Hammondsport producer and pilot. They brought it up, fitted it with pontoons, and Mr. Curtiss soared successfully over the lake in it.

After this occurrence the relationship between the two men was steadily intensified. Mr. Manly was consulted by Mr. Curtiss frequently, and finally became consulting engineer and later Chief Inspection Engineer for the Curtiss Corporations. He is well known as the author of the Langley Memorial. He has given advice on the plans of all Curtiss machines of the last several years. He was Consulting Engineer to the British War Mission in 1914, and helped develop the Model C ("Canada") bombing aeroplane for the English Government. He has made several trips to Europe and has acted for the corporation in many of its dealings with foreign governments.

Another early worker, a pioneer aeroplane and motor builder, is Charles B. Kirkham. His aeronautical engines were used by the Thomas and Burgess companies, and in machines of Mr. Kirkham's own. He has been with the Curtiss interests for several years, and has been largely responsible for the design of the Model 18-T triplane, the fastest machine in the world to date, and the new K-6 and K-12 Curtiss motors.



Early Curtiss Model J

Also associated with Mr. Curtiss as a consulting engineer is Henry Kleckler, a natural designer, with experience from the



Curtiss Model HA Hydro Tractor

old Hammondsport days; also W. L. Gilmore, a recognized authority on water craft design and manufacture.

The general work of the Curtiss Research Department is under especially able and keen supervision. John P. Tarbox has had both a legal and an engineering training. He has used both in his connection with the Curtiss Corporations. His experience in patent law has been valuable to the company; his knowledge of engineering had become effective in active encouragement of new ideas and enthusiastic assistance to members of his staff in every stage of the development of their work.

Dr. A. F. Zahm, recognized as an international authority, is another man who has been prominent in the Curtiss organization.

Designers of this calibre, aided by Mr. Curtiss himself with his experience, genius, and great mental activity, were bound to sustain and advance the reputation which the old Curtiss companies had passed on to the new corporation. The standard Curtiss land



Early Curtiss Model J fitted with Pontoons

machine, the JN-4-A, was an excellent training machine, but it was developed into the better known and more advanced JN-4-D and JN-4-H types—machines which have thrust their yellow wings across the sky line of every flying field in the United States.

Other Curtiss machines, the



Curtiss Model L-1 Tractor

R-4-L's, have been equipped with Liberty motors and used for mail carrying. And well they may be, for Curtiss machines were the first to carry letters for Uncle Sam. They have proved their value for mapping work and travel. The expedition of Major Albert Smith, which flew in formation from San Diego to New York but recently, without losing a single machine, was equipped with Curtiss JN-4-H's.

The thousands of training machines which the nine Curtiss factories produced were only part of a large program. The more than 2,000,000 square feet of floor space and the 18,000 employees of the Corporation were able to carry on much other work of equal importance with the manufacture of training planes.

Two great tasks may be noted. One was the production of Curtiss motors in quantity—the OX and OXX of various types. The Curtiss work began with motors, and during the war the corporation sustained an old reputation by an enormous output. The OX's, especially, were in the engine room of every ground school, and on the training planes of all flying fields.

Curtiss engineering and research talent was consulted by U. S. Naval and Army representatives throughout the period of the war. In April, 1917, the Naval war contracts began. And the Curtiss floors were filled with R-6 and R-9 seaplanes,



Early Curtiss Triplane Racer



Curtiss Model L-2 Hydro Tractor

H-12 flying boats, H-16 and H-16-A types, L-2's, HS-2-L's, and F-5's. The NC-1, which broke the world's passenger-carrying record in the fall of 1918, was built by the Curtiss Engineering Corporation at Garden City. Its 126 foot wing spread, its graceful lines, its 90 miles per hour speed, and its capacity of over fifty passengers, make a marvelous contrast to the first of its type which Curtiss, the inventor, was driving over the waters of San Diego bay over seven years ago.

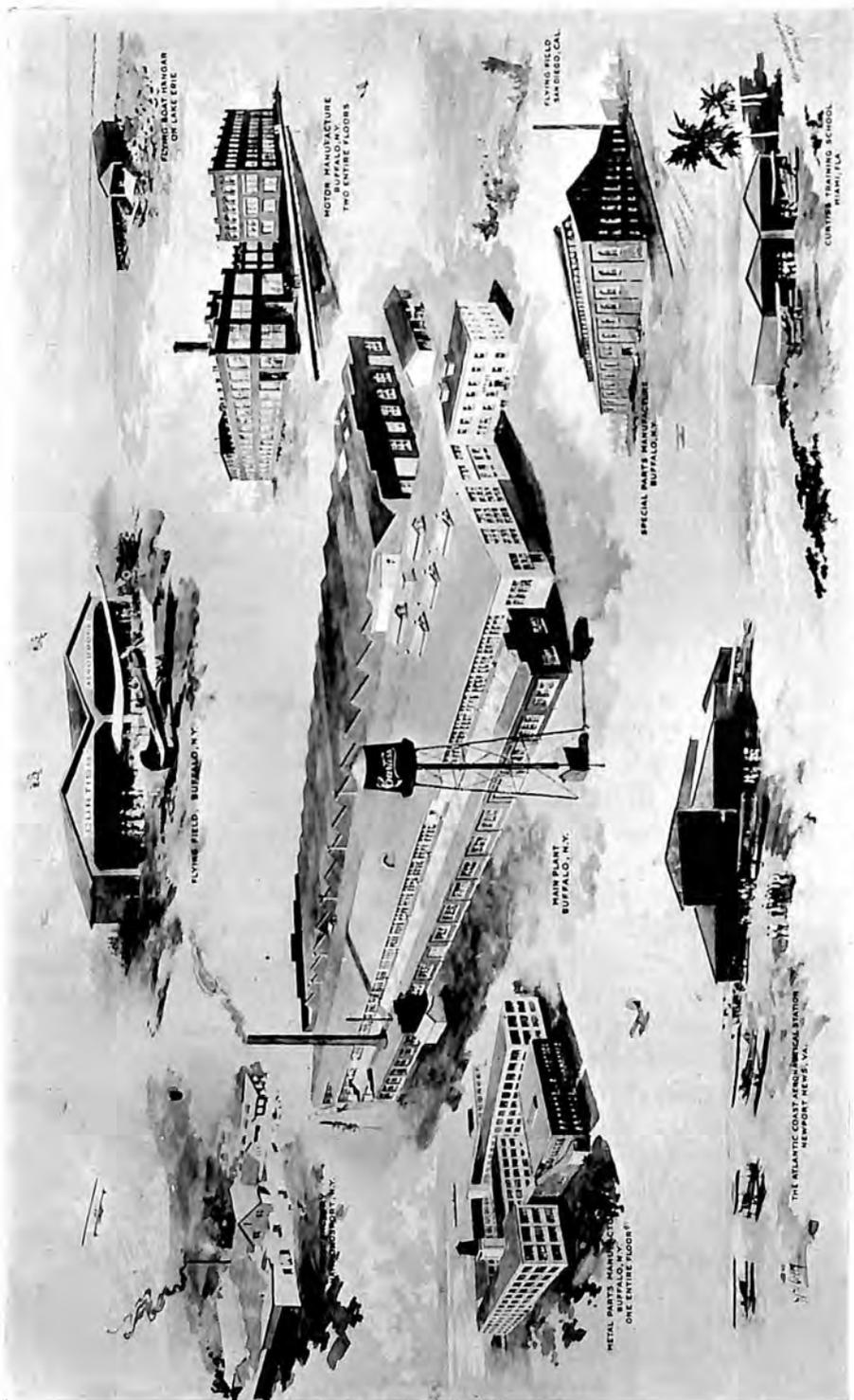
The Curtiss Aeroplane and Motor Corporation also entered on Spad, Bristol and SE-5 contracts. If the war had continued it would have produced several thousand of these. The signing of the armistice stopped all this—though complete operating tools and schedules had just been tested to accomplish the building of 300 machines per week.

At the time that the amalgamation of Curtiss and Willys interests took place, there were in operation all of the Buffalo plants with the exception of the big North Elmwood works—the largest in the World.

Upon the retirement of Mr. Morgan as general manager in January, 1918, Mr. Willys placed J. E. Kepperley in charge. Previous to this time, Mr. Kepperley had been legal advisor for the Willys-Overland. Taking hold of the Buffalo plants, Mr. Kepperley proved himself a man exactly fitted to the needs called for by the tremendous



Early Curtiss Triplane Hydro



Views of other Curtiss Plants and Flying Fields

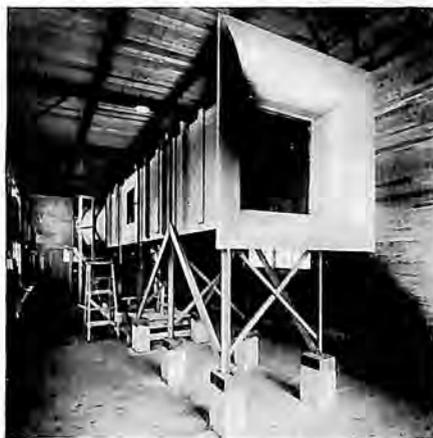


Curtiss Engineering Corporation Plant and Executive Offices, Garden City, L. I.

war activities and demands. Through his remarkable ability as an organizer and co-ordinator, his keen insight into the best methods of maximum production, gained through his close affiliation with Mr. Willys, the various plants began to turn out planes at the rate of 112 complete machines per week and had not the armistice been signed, the promised delivery of fifty a day would have been realized. Before and during the war, Curtiss plants turned out some 10,000 aeroplanes and boats and 15,000 motors—all of which played an important part in the task of "putting out the eyes of the enemy.

During this period, there was produced at Garden City, the Curtiss 18-T triplane, now well known as the speediest machine in the world. It has done 165 miles per hour. The craft is a triumph in streamlining. Not a square inch of the machine, from tail skid to exhaust pipes (they are curved to the flow of wind), has been omitted from the careful plan of shaping, which has cut down resistance to the minimum. The 309 square feet of supporting surface and the power of the new K-12 Curtiss motor carry the gross weight of 2,900 pounds represented by the triplane, fully loaded, to a height of 15,000 feet in ten minutes.

The new K-6 and K-12 motors may well conclude the list of Curtiss efforts, for they bring the company back to a success



Small Wind Tunnel, Garden City Plant



Army, Navy, and Curtiss Chief Executives at Buffalo

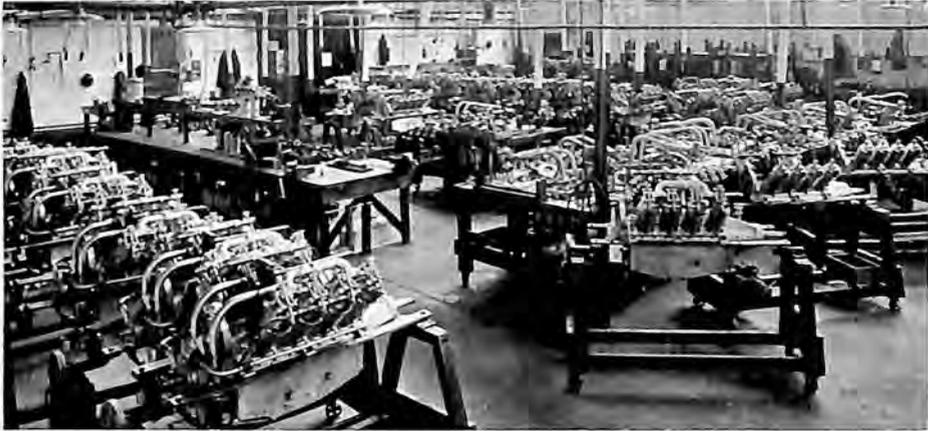
on its first aeronautical endeavor. An indication of their capabilities is in place. The K-12 is a Vee type of aluminum construction, developing 400 H. P. at 2500 R. P. M. of the crank shaft. It is served by two high tension, two spark 6-cylinder magnetos. It uses a centrifugal pump for the water cooling circulating system, and pressure feed for oil. Its cylinders have a bore of $4\frac{1}{2}$ inches and a stroke of 6. Without oil or water it weighs 680 pounds, a dead weight of 1.70 pounds per horse-power. It has an overall length of $68\frac{5}{16}$, a width of $27\frac{7}{8}$ and a depth of $40\frac{1}{8}$ inches. Its quality may further be seen in the performance of the Curtiss speed triplane.

The K-6 develops 150 H. P. at 1700 R. P. M.; has the same general structural and operating features as the K-12 type, and weighs 400 pounds—a dead weight of 2.75 pounds per horse power. It is not a Vee, but a bloc type, 63 inches long, $22\frac{3}{8}$ inches wide, and $39\frac{1}{4}$ inches deep.



Early Curtiss Pilots

The new plane and the new motors indicate that if the Curtiss Corporation is one of the

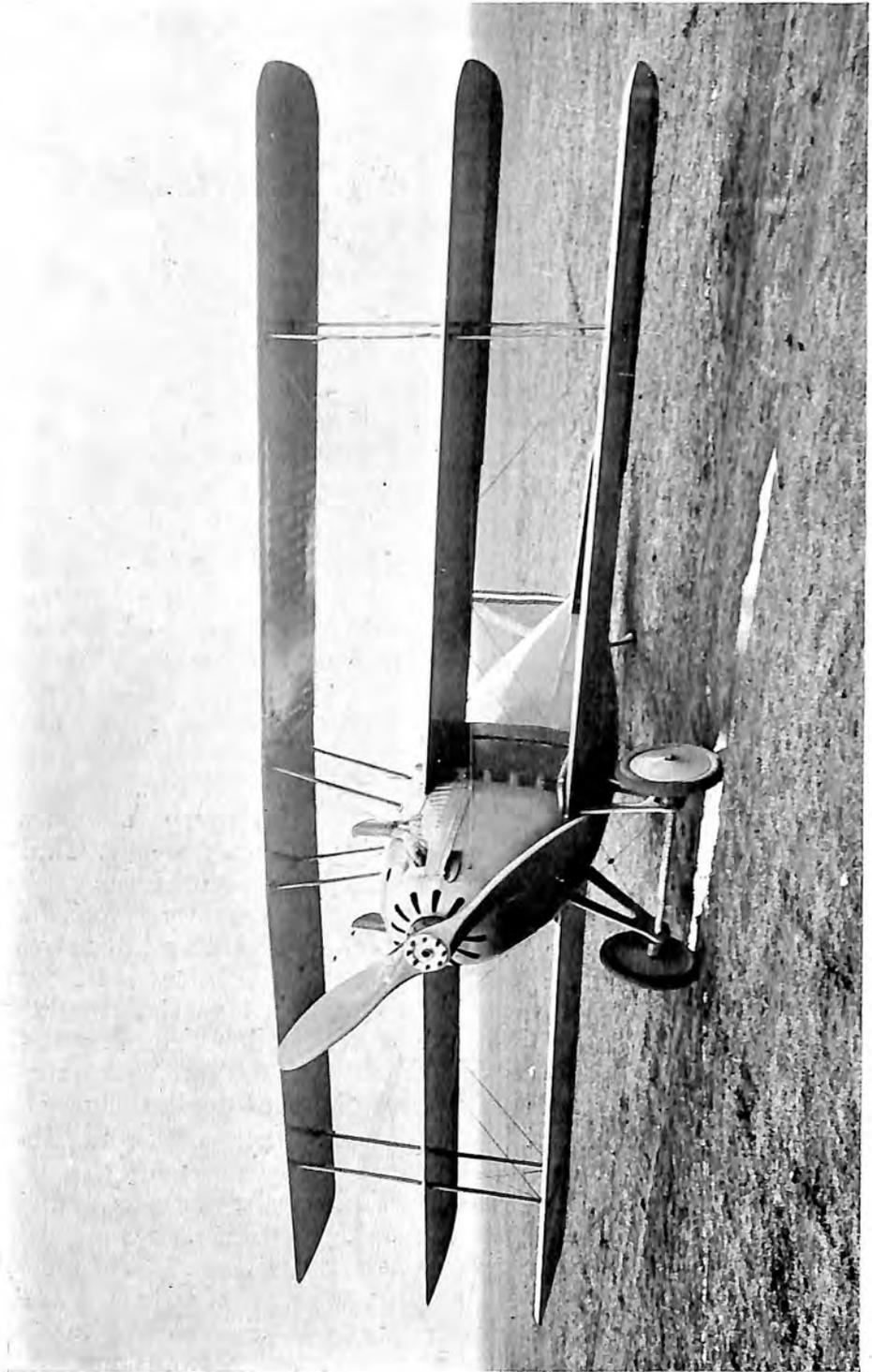


Motor Assembly Floor, Hammondspport Plant

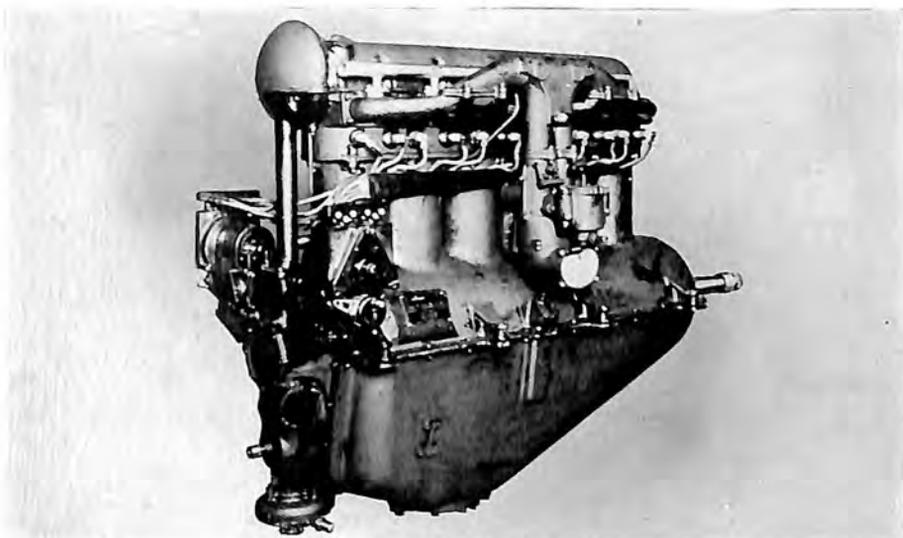
oldest, it is likewise one of the most vigorous of American aircraft companies. Like its founder, it is young—young indeed in years, as the entire industry is, but young also in its ability to keep a receptive, progressive outlook. It does not plan to stand still. Through with war work, the Curtiss Corporation has turned its attention to aerial commerce. It has furnished the Government mail planes; training machines, seaplanes, flying boats and aeronautical motors; yet it has had time to develop after-war types. Corporations have planned to establish passenger lines running along the Atlantic Coast from New York to Miami, Fla. One will also maintain a land airplane taxi-service, with a depot at Garden City. All of these have contracted to use Curtiss machines.

Mr. Curtiss, himself, in the early days at Hammondspport, foresaw the important part that the aeroplane would play in the event of war; but his vision as to the future of flying extended beyond that. He realized that he was working on an idea that would be an agency of peace more than one of destruction. He saw in the aeroplane a means of promoting the world's welfare, a means of lightening men's burdens. His predictions of mail delivery by aeroplane, exploration, travel, transportation, pleasure—all of these have already been fulfilled.

With the world conflict ended, Curtiss energies are already being directed along these channels. Numerous types of planes are being now built and developed along commercial lines. It is the idea of Mr. Curtiss that the greatest development will come first in water machines on account of the availability of landing places, but that it will be closely pressed by land machines, the development of



The fastest Aeroplane in the world—Curtiss Model 18-T Tractor

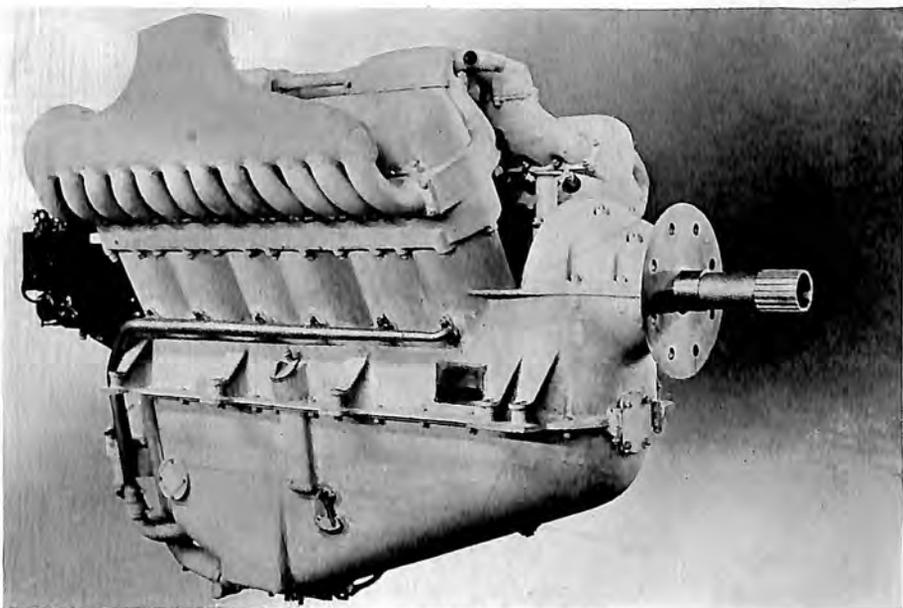


Curtiss Aeronautical Motor, Model K-6

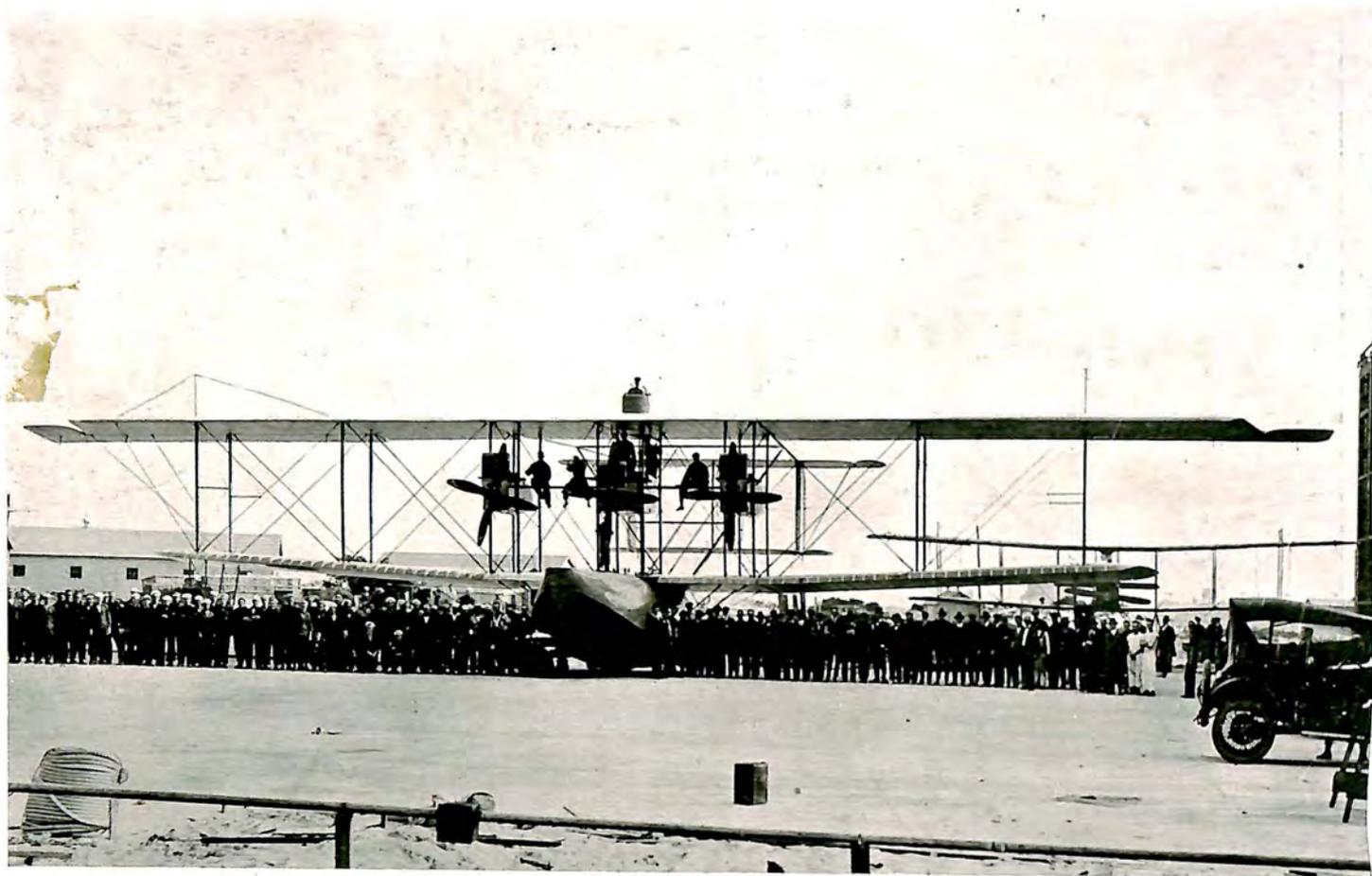
which will depend entirely upon the construction of landing fields.

Curtiss engineers and manufacturing executives are ready for this new era.

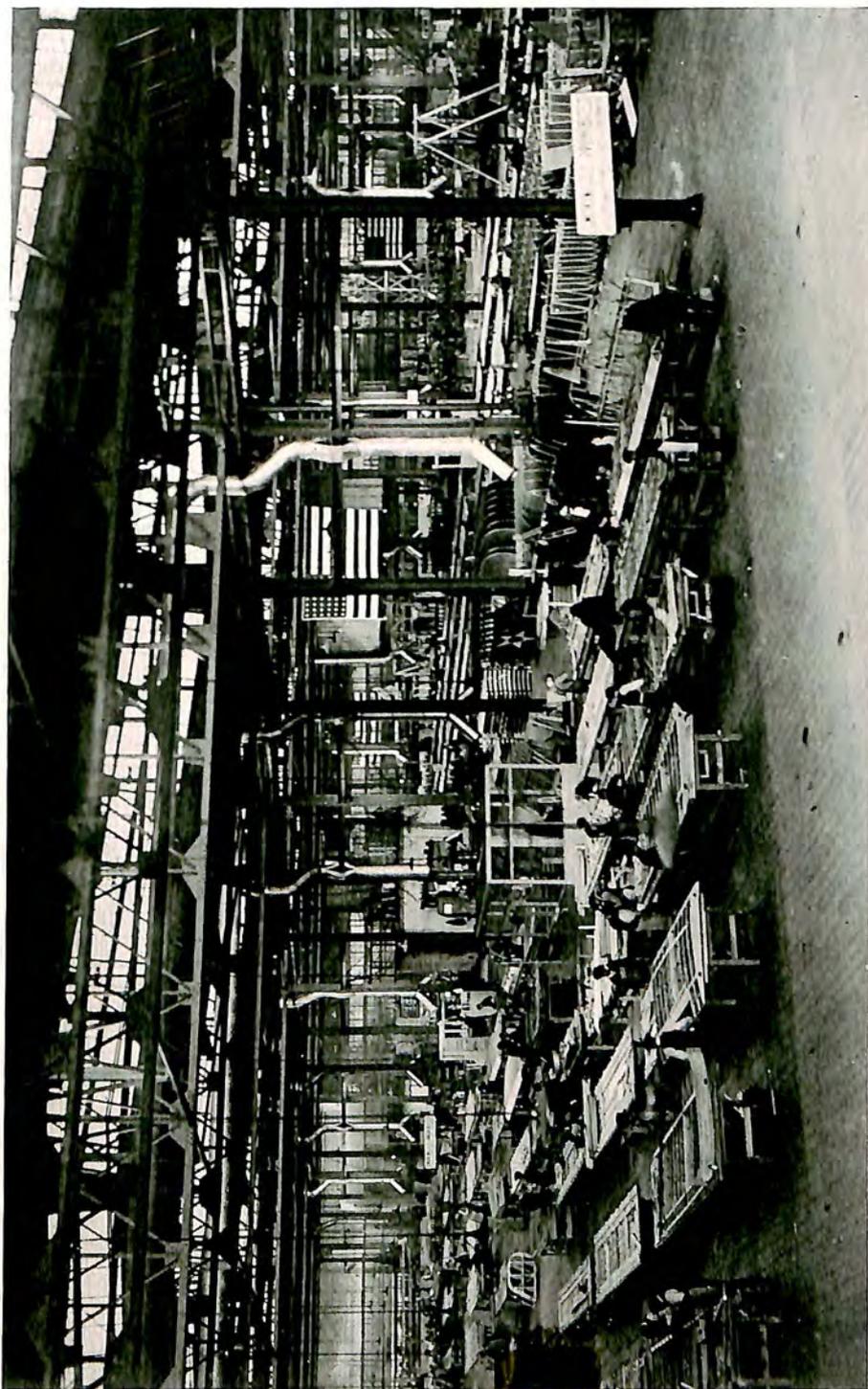
The Corporation has established sales offices at 52 Vanderbilt Avenue, New York City.



Curtiss Aeronautical Motor, Model K-12



The Giant Flying Boat NC-1, built for the U. S. Navy, at the Curtiss Engineering Corporation, Garden City



The Wing Panel Department in the Curtiss North Elmwood Plant, Buffalo



A few of the thousands of women working in Curtiss shops



The Dayton Wright Plant, No. 3, Dayton, Ohio

DAYTON WRIGHT AIRPLANE COMPANY

DAYTON, OHIO

J. E. TALBOTT, JR. *President*
 C. F. KETTERING *Vice-President*
 GEORGE H. MEAD *2d Vice-President*
 ORVILLE WRIGHT *Consulting Engineer*

Directors

COLONEL H. E. TALBOTT, *Chairman*
 H. E. TALBOTT, JR. ORVILLE WRIGHT
 C. F. KETTERING GEORGE H. MEAD

PLANT No. 1—Moraine City, Ohio
 PLANT No. 2—Miamisburg, Ohio.
 PLANT No. 3—Dayton, Ohio.

THE Dayton Wright Airplane Company was incorporated on April 9, 1917, for the fundamental purpose of bringing together such executive, manufacturing and engineering ability as would be of benefit to the government in the carrying out of its prospective aircraft program.

Until August, 1917, at which time a contract for four hundred training planes was awarded by the Government to the Company, the work, which was largely of an experimental nature, was carried on at what is now known as the South Field Experimental Station. Some time elapsed before the original contract was amended, the final order calling for the delivery of four hundred training planes and five thousand DeHaviland-4 Battle Planes, the latter to be equipped with Liberty Motors.

At the time of the signing of the Armistice with Germany, a total of four hundred training planes and two thousand seven hundred

and three DeHaviland-4 Battle Planes had been completed and shipped. Orders were then received by the Company to discontinue production after the completion and shipment of the three thousand one hundredth DeHaviland.

It is a fact worthy of note, that, at the time of the signing of the Armistice, between 1,800 and 2,000 DeHaviland-4's made by the Dayton Wright Airplane Company had been received in France.

The principal plant of the Company is located at Moraine City, a distance of some four miles from the City of Dayton. Plant No. 2 is located at Miamisburg, about eight miles from Dayton, and Plant No. 3 is the original plant of the Wright Airplane Company and is situated in Dayton.

The Board of Directors of the Company is as follows:

COLONEL H. E. TALBOTT, *Chairman.*

H. E. TALBOTT, JR., *President.*

C. F. KETTERING, *Vice-President.*

ORVILLE WRIGHT, *Consulting Engineer.*

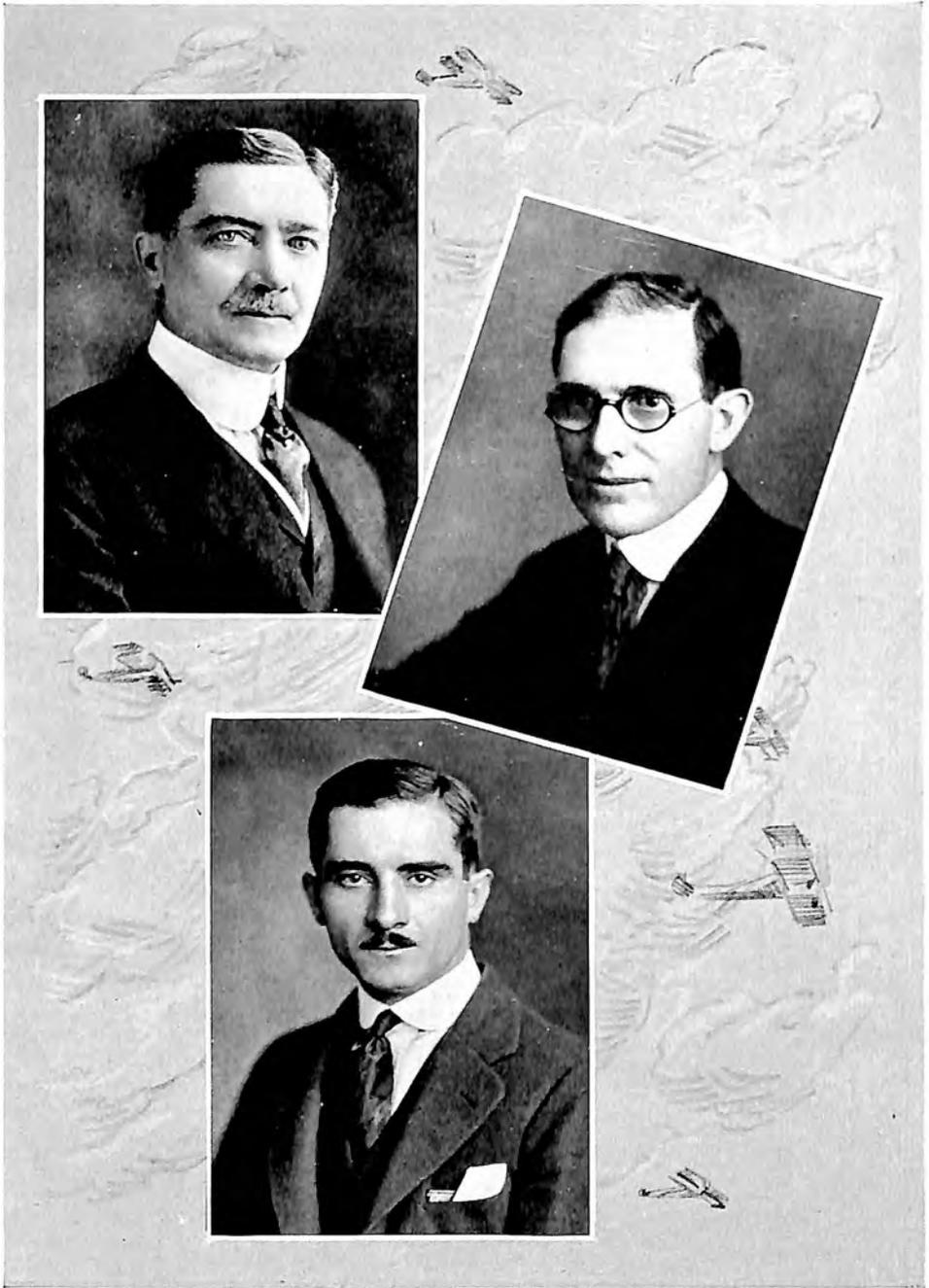
GEORGE H. MEAD, *Second Vice-President.*

Colonel H. E. Talbott, who is Chairman of the Board of Directors, has been actively interested for the past thirty years in engineering and construction work in various parts of the United States and Canada. The H. E. Talbott Company under his direction as president, has erected several of the largest water power and paper mill developments on the continent. Colonel Talbott's early activities were largely in connection with the building of railroads from which work developed the assumption of more extensive contracts. Shortly after the declaration of war between Germany and the Allies, Colonel Talbott organized and incorporated the Dayton Metal Products Company. This firm was engaged for three years in the manufacture of detonating fuses for the British and Russian governments. Upon the entrance of the United States in the war, the facilities of this plant were turned over in their entirety to the United States Government and later were engaged in the extensive manufacture of munitions for our armies. This work was carried on successfully until the signing of the Armistice.

In April, 1917, Colonel Talbott, in company with Mr. C. F. Kettering and H. E. Talbott, Jr., organized the Dayton Wright Airplane Company, and in so doing took over the nucleus of the original Wright Brothers manufacturing organization. It may be said in this connection, that during the year of 1916, prior to the incorporation of the Company, this same organization had been carrying



Dayton Wright Plant No. 2



From top to bottom, COLONEL H. E. TALBOTT, CHARLES F. KETTERING,
H. E. TALBOTT, JR.

on development work with the idea of assisting the Government in making preparations for the war, which at the end of that year seemed inevitable.

Subsequent to the formation of these two companies, a number of civilian aviators were trained at the flying field of the Wright Field Company, and the development work which had been carried on during the year of 1916 was continued by the Dayton Wright Company. The activities of the Company for some time following its incorporation and prior to the undertaking of Government contracts were directed toward the development of such model training planes as might be utilized for the preparation of our air forces.

Mr. H. E. Talbott, Jr., has for some years past been associated with Colonel Talbott in various enterprises. In his capacity as General Manager of the H. E. Talbott Company he has directed all of the extensive construction work undertaken during the past ten years. Upon the organization of the Dayton Metal Products Company, Mr. Talbott, Jr., became General Manager, which position he still retains.

Mr. Talbott, Jr., is also actively interested as a Director in several of the large industrial concerns and transportation companies in Dayton.

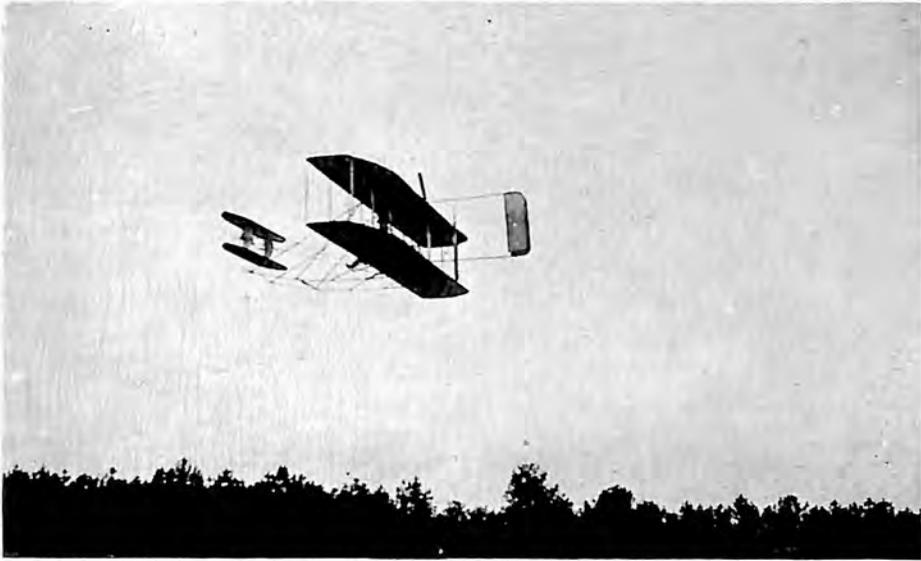
Mr. Charles F. Kettering is most widely known, perhaps, as President of the Dayton Engineering Laboratories Company (Delco), and it may be said in this connection that he has been responsible for the development of the automobile starter and battery ignition system to their present high states of efficiency.

Mr. Kettering's interest in aeronautics manifested itself in 1916, when in co-operation with Mr. Orville Wright, he organized aeronautical laboratories for the purpose of carrying out ideas, the adoption of which might be beneficial in the construction of airplanes. This work was carried on personally by Mr. Kettering and Mr. Wright until the incorporation of the Dayton Wright Airplane Company, and their activities were coincident with the preparedness atmosphere which was prevalent before the United States entered the war. The work carried on was entirely without profit, and several of the ideas developed at this time have since been embodied in the more recent types of fighting craft.

It is hardly necessary to describe here Mr. Orville Wright's activities in the development of the airplane. Mr. Wright's interest in aeronautics dates back as far as 1899, at which time he and his brother Wilbur started work on the development of a heavier than



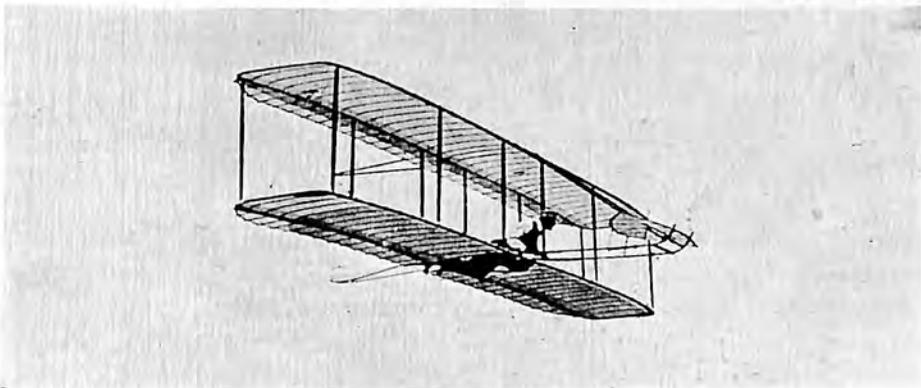
ORVILLE WRIGHT



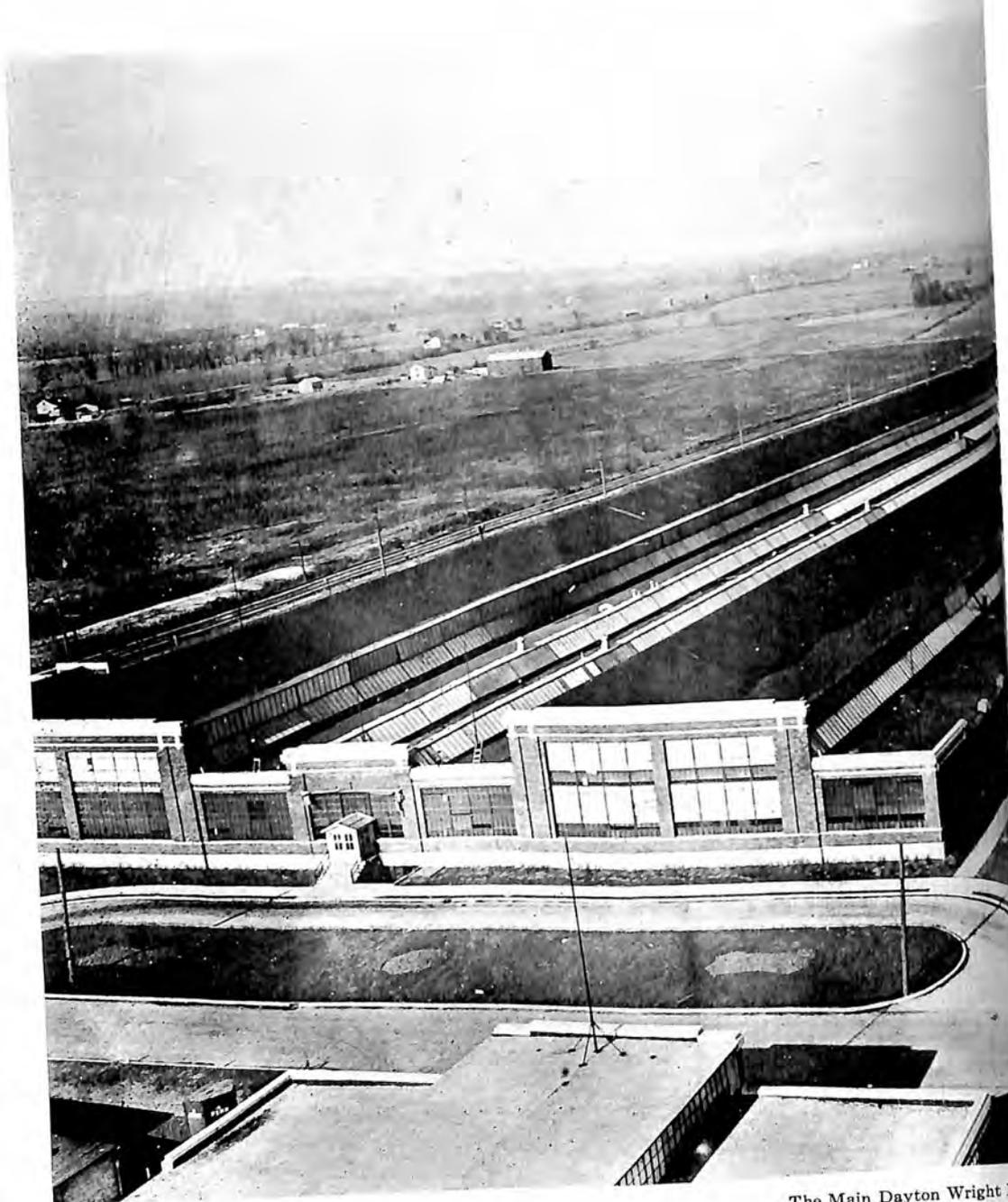
Flight of the Model A, Kitty Hawk, 1908, motor 30 H. P., span 41 feet. Flown in the United States, Italy, France, and Germany

air machine which would be sufficiently mobile to permit of practical flying. Some of their first experiments were carried out in Dayton and others in Kitty Hawk, North Carolina. The first actual heavier than air machine was a glider, flown in the year 1900, at Kitty Hawk. The span of this plane was 18 feet with a chord of 5 feet. Most of the experiments with this glider were made as a kite, operating the levers by cords from the ground.

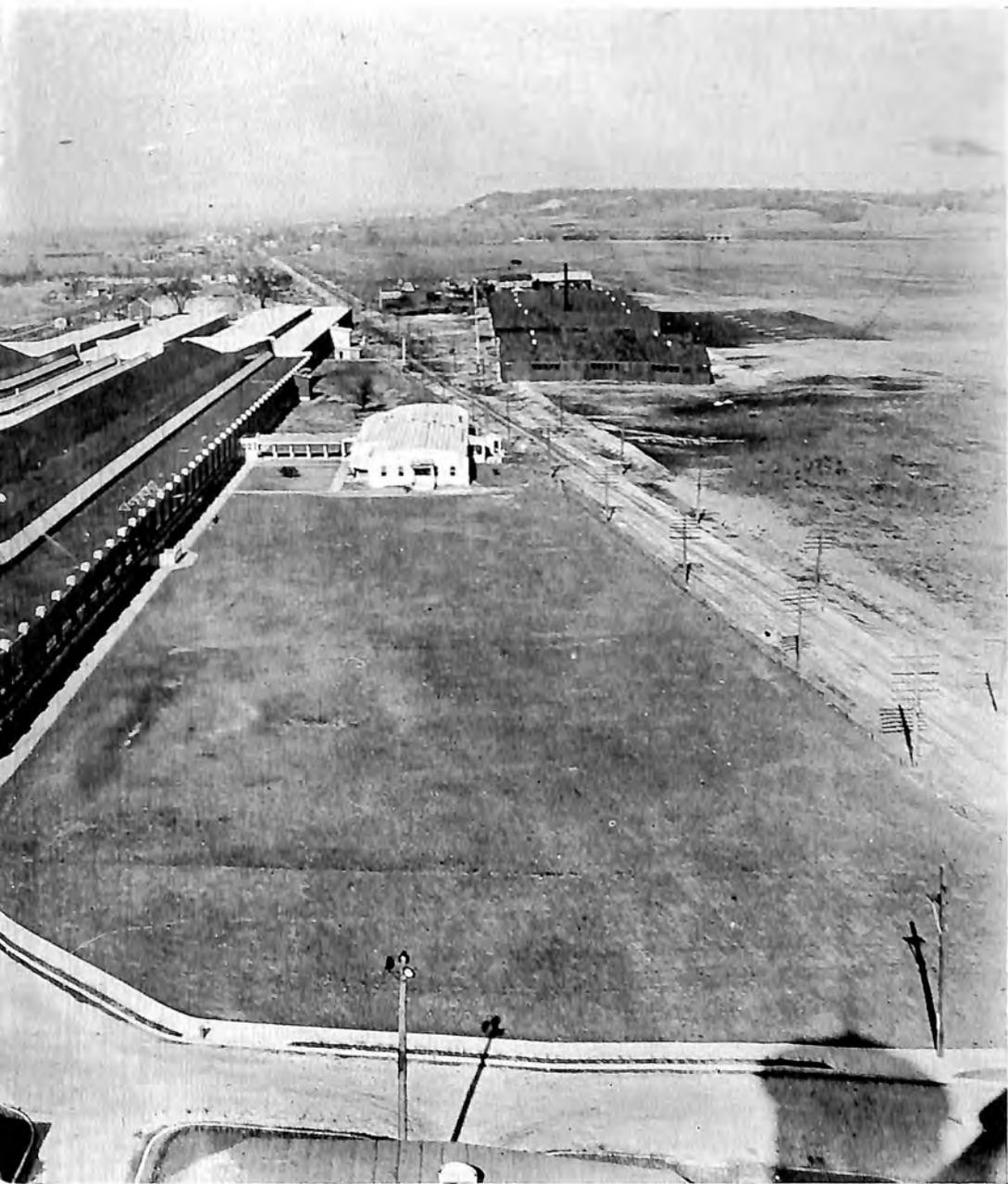
In 1901, the second glider, having a span of 22 feet with a chord of 7 feet and carrying Mr. Wilbur Wright, was flown with some degree of success at Kitty Hawk.



The original Wright Glider, 1902



The Main Dayton Wright



showing north section of test field

The last glider, prior to the adoption of the gasoline motor, had a span of 32 feet and a chord of 5 feet.

In 1903, the Wright Brothers developed a power machine having a span of 41 feet and a chord of $6\frac{1}{2}$ feet. Inasmuch as the Wrights had been previously unable to secure a satisfactory motor for this plane, they invented and made one which met their requirements and which developed from 10 to 12 H. P. The motor was of the horizontal type. The weight of the machine complete with the operator was 750 pounds. This machine made the first flight in the history of the world at Kitty Hawk, North Carolina, on December 17, 1903.*

Having thus far succeeded, Mr. Wright directed his efforts to the improvement of both plane and motor until such time as the attention of Foreign Governments was attracted and he was given considerable moral and financial encouragement toward the carrying on of his work, where previously he had met with little other than scepticism.

The detailed story of the development of Mr. Wright's plane from a glider to a gasoline-motored air vehicle, is, probably, one of the most interesting histories of mechanical achievement on record.

Mr. Wright, while being a Director of the Company, has acted at all times in the capacity of Consulting Engineer and numerous experiments and tests have been carried out in his laboratories in Dayton, leading to the adoption of many improvements in the present day airplane.

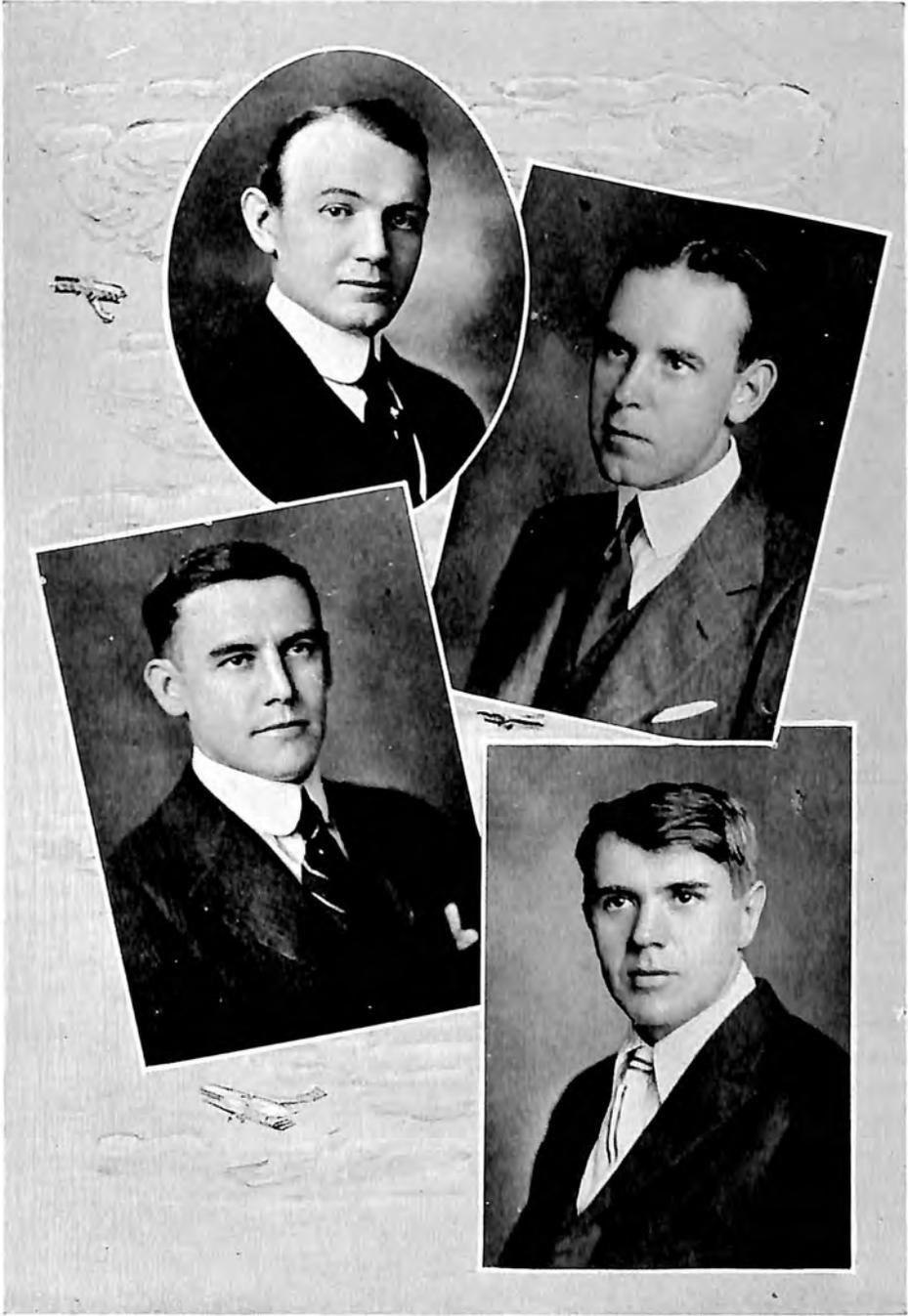
Mr. George H. Mead is president of the Spanish River Paper Corporation and the Lake Superior Paper Company. Under his administration both of these companies have developed into two of the largest paper companies on the continent.

Mr. Mead's actual activities in the carrying out of the Government contracts with the Dayton Wright Airplane Company have been largely from the financial end.

The executive manufacturing organization of the Company has been picked with the idea of placing men in responsible positions, who, due to their previous organizing and operating experience, have been successful in other lines of work.

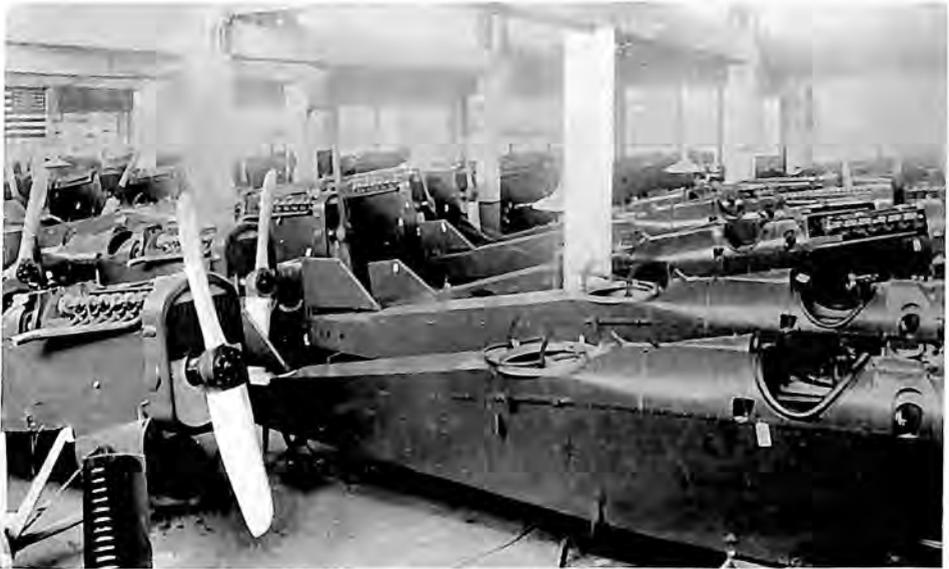
Mr. G. M. Williams, General Manager, has been affiliated with Colonel H. E. Talbott and Mr. H. E. Talbott, Jr., in various capacities since 1911, at which time he joined the organization as Assistant Engineer of construction of hydro-electric and paper mill

*The detailed story of this flight is told by Mr. Wright later in the volume under the heading, "How We Made the First Flight."



G. H. MEAD
G. M. WILLIAMS

J. M. SCHOONMAKER, JR.
HOWARD M. RINEHART



Group of De Haviland-4 fuselages ready for final assembly of wings, center sections, and tail surfaces

developments in Canada, later being made Construction Engineer. At the time of the organization of the Dayton Metal Products Company, he was assistant to the Vice-President and acted in this capacity during the carrying out of the contract with the British and Russian governments, later being transferred to the Dayton Wright Airplane Company's organization in charge of manufacturing.

Mr. J. M. Schoonmaker, Jr., Chief Engineer, joined the organization of the H. E. Talbott Company in 1913, as Electrical Engineer. Prior to the organization of the Dayton Wright Airplane Company, Mr. Schoonmaker had made an exhaustive study of construction of airplanes and motors, and it may be said in this connection that he was one of the first engineers who worked on the original design of the Liberty Motor, having been called to Washington for this purpose, upon the declaration of war on Germany by the United States.

Mr. Schoonmaker is also connected in an executive capacity with the Standard Steel Spring Company of Coraopolis, Pennsylvania.

Mr. Howard M. Rinehart, who has charge of all tests, holds the unique position of being one of the first airplane pilots. Mr. Rinehart received his early training under Mr. Orville Wright at the Wright School and was later engaged by Mr. Wright as an instructor.

Mr. Rinehart's activities in aeronautics are not confined entirely



Interior view of Mill

to his ability as a pilot, he having spent the last ten years in research work on the development of the airplane.

As before described, the principal plant of the company is located at Moraine City, a short distance from Dayton. This plant was originally designed for use by the Domestic Engineering Company of Dayton for the manufacture of Delco Light Products, but was turned over to the Dayton Wright Airplane Company on account of its adaptability to the manufacture of airplanes in quantity.

The main building is 1,350 feet long by 270 feet wide, and in addition there is a mill building 400 feet long by 100 feet wide. All of the buildings, comprising the main plant, are of concrete, brick and steel construction with bays 20 feet by 30 feet in the main assembly section and 30 feet by 50 feet in the final plane assembly. The latter permits of the free movement of the completely assembled DeHaviland Planes for the various operations of the plane in its final stages of completion.

Other buildings, which comprise the main plant, are dry-kilns, hangars, motor test buildings, garage, boiler houses and commissary building. The main plant is devoted almost entirely to the assembly of such parts as are made in subsidiary plants of the company in Miamisburg and Dayton.

The Company's next plant in importance as to size is that at Miamisburg. This plant was acquired in order to increase manufacturing



Loading the 1,000th De Haviland on cars, July 31st, 1918

facilities, and lends itself for this purpose particularly on account of the local labor market and the facilities of transportation. This plant was taken over by the Company in 1917.

Plant No. 3 has been used exclusively in the manufacture of metal parts and fittings and was the original plant used by the Wright Airplane Company.



DeHaviland-4 as it looked on July 31, 1918



DeHaviland-4 No. 1000 after test

The Company's experimental station, better known perhaps as "South Field," is situated a short distance from the main plant. A total of 65,000 square feet of floor space comprises practically a complete factory on a small scale for the turning out of completed airplanes. South Field has been used during the war and also prior to that time for the development of such models as would be adaptable for military purposes. The first DeHaviland-4, in fact the first battle plane of any type to be made in this country, was built entirely at this experimental plant. Here also has been developed the DeHaviland-9A. At the present moment planes of a type which are more or less adaptations of the original DeHaviland are being developed and made for the Government.

In addition to the above, a great deal of work in this experimental department has been of a secretive nature, and for this reason it is not permissible to explain in detail some of the more interesting military developments which have been carried out there.

During the latter part of 1918 the company employed 8,000 people. The maximum production reached prior to the signing of the Armistice was forty planes per day, and production records show that for the week prior to the cessation of hostilities, two hundred and one planes were completed and shipped.

One of the above photographs shows the loading of the one thousandth DeHaviland-4 on the cars July 31st. It is interesting,



View of Test Field showing one week

perhaps, to mention that on April 27th the management authorized a schedule calling for the completion of the one thousandth plane on July 31st, the plane to be complete and ready for shipment on the New York Central train leaving the yards at 4.30 P. M. It may be said to the credit of the manufacturing organization that at 3.30 P. M. on July 31st, the plane was completely packed and actually loaded on the cars at 3.57 P. M. This occasion was celebrated by the employees of the plant as somewhat of an unprecedented achievement. The one thousandth plane is recorded as having arrived in France on September 7th.

In spite of the many difficulties which were encountered due to changes in design, delays brought about by difficulty in securing material, and the many other obstacles that necessarily had to be met and overcome, the Government's records show between 1,800 and 2,000 DeHaviland-4's made by the Dayton Wright Airplane Company having been actually received in France at the time of the signing of the Armistice.

The general history and progress of the Company is representative perhaps of the advances that have been made in the aircraft industry in this country during the past two years. The first activities were confined entirely to the small experimental plant, thence going through the various stages of developments into the present large organization.

With the calls from the Government for increased production, came the acquiring of additional property and manufacturing facilities.

The company's production has been confined exclusively to airplanes of a military type which have been made under contracts with the Government and the result is that at the cessation of extensive



Production of planes prior to being crated

Government production, over 3,500 training planes and day bombing planes had been completed and shipped.

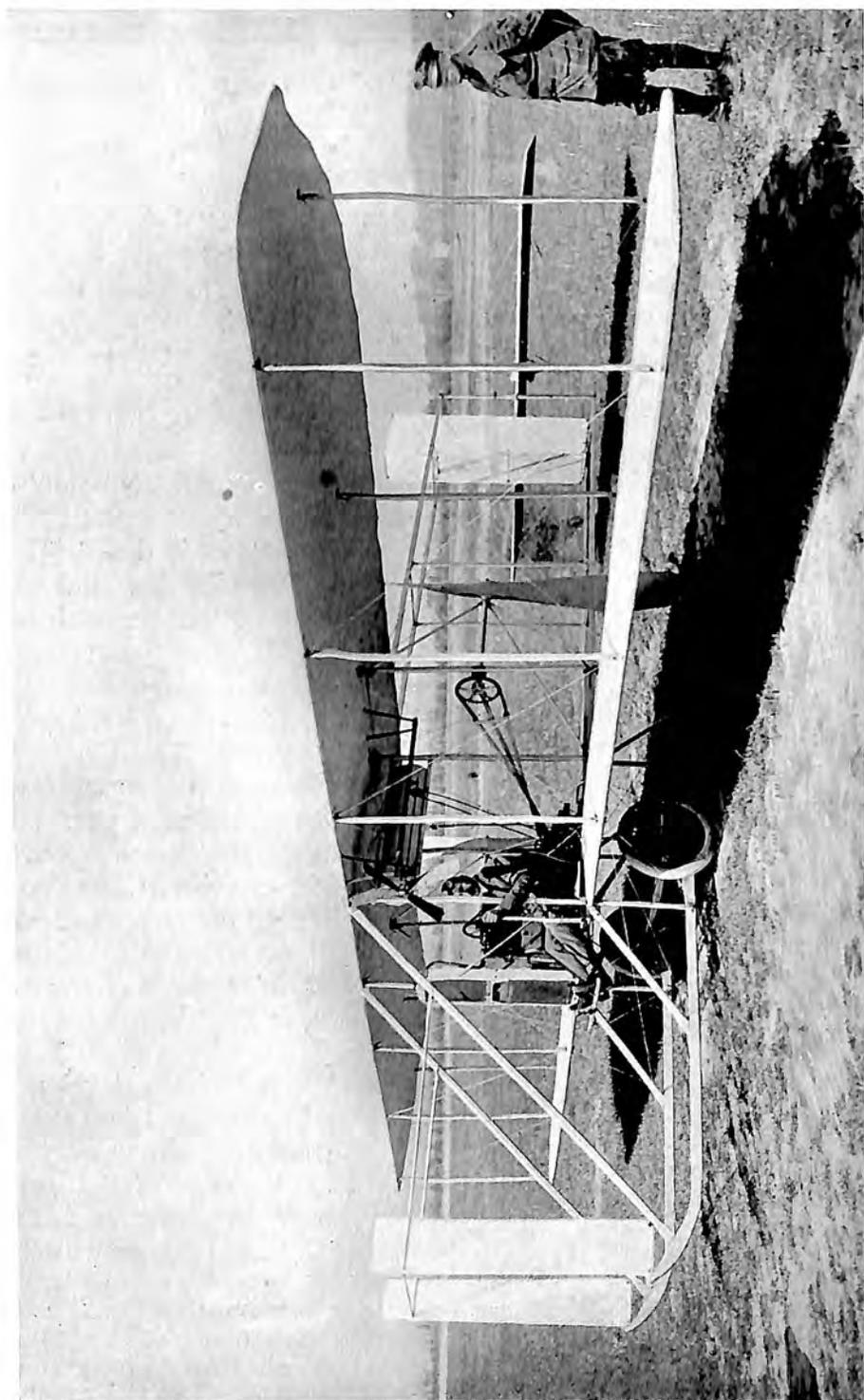
Principal, of course, amongst these military types is the DeHaviland-4 previously described as a day bombing machine equipped with a Liberty motor. This plane has been eminently successful as a general purpose plane on the Western Front, two of its most notable features being climbing ability and speed. Communications which have been received from France point to the fact of its having been the most successful plane in use on the Western Front.

The photograph on page 147 shows a close-up view of the DeHaviland-4 made by the Dayton Wright Airplane Company. The photograph was snapped upon the return of Mr. Orville Wright from a crosscountry flight, having been piloted by Mr. Howard M. Rinehart.

The photograph on page 146 shows Mr. Wright preparing to make an ascent in one of the early B-type machines. It should be noted that this plane has the original warping wing, which is the fundamental principle of lateral control and which was conceived in the pioneer days of aeronautics by Mr. Wright.

Several variations of the DeHaviland Type have been developed and manufactured by the Company. Notable amongst these is the "Long Distance" DeHaviland-4 with a special gasoline carrying capacity for nine hours continuous flight. In a plane of this type Howard M. Rinehart, accompanied by Mr. C. F. Kettering, made the flight from Dayton to Mineola in four hours and two minutes without stop. A small number of these Long Distance planes are now being turned out for the Department of Military Aeronautics.

In addition there has been developed and manufactured the "Blue Bird" DeHaviland-4 with complete dual control. These planes may be operated from either rear or forward cockpits. While the regular



Mr. Wright in an early B-type machine



Mr. Wright and Mr. Rinehart, with a DeHaviland-4

production DeHaviland embodies this feature to a certain extent, the rear control of the regular type is used only in the case of the most extreme emergency, in which case the observer may make a forced landing should accident befall the pilot. The "Blue Bird" is equipped with a complete duplicate set of instruments, spark and throttle control, gasoline supply, control assembly, etc. This type will in all probability be used primarily as an advanced type of training plane.

Another special type of DeHaviland which has attracted a great deal of interest in aeronautical circles is that known as the "Honeymoon." This is a three-passenger type, the passenger compartment of which is especially commodious and comfortable. The control is single and the pilot's cockpit is forward. The passengers sit one behind the other in a large passenger cockpit. Some of the additional features which have been added for the sake of convenience is a robe rail, field glass rack and very comfortable upholstered arm chairs.

Still another development is the small "Messenger" plane. This undoubtedly is one of the smallest man-flown airplanes in existence. It is equipped with a four-cylinder, forty H. P. air-cooled motor and develops a speed of eighty-seven miles per hour with a landing speed of thirty-five miles per hour. This plane was designed primarily for liason purposes and has attracted a great deal of interest from both American and Foreign pilots.

The activities of the Company at present are concentrated

principally on the completion of such Government orders as are still unfilled.

Work of a development nature is being carried on, however, at the experimental station, and it is hoped that within the next few months appreciable progress will have been made in the development of a number of types which are particularly adaptable to Peace-time requirements.

THE ENGEL AIRCRAFT COMPANY

NILES, OHIO

W. D. SAYLE *President and General Manager*

A. J. ENGEL *Vice-President and Production Manager*

G. S. PATTERSON, *Secretary and Treasurer and Executive Manager*

Directors

W. D. SAYLE

A. J. ENGEL

JOEL H. FULLER

GEORGE T. FILLIUS

T. E. THOMAS

F. C. CASE

A. J. BENTLEY

S. L. PIERCE

PLANT—Niles, Ohio.

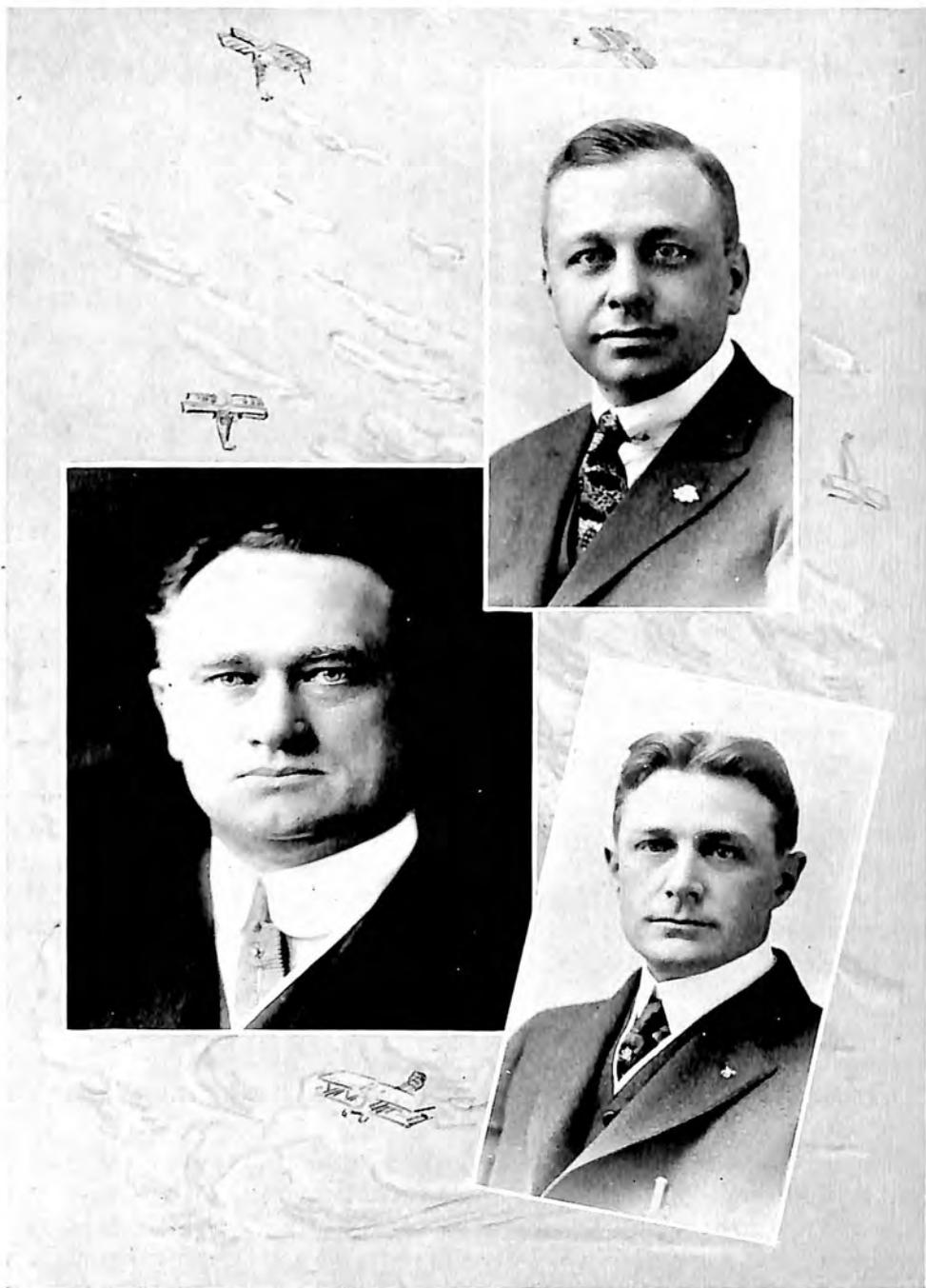
GEORGE S. PATTERSON

THE Engel Aircraft Company was organized in August, 1917, at Niles, Ohio, for the purpose of building aircraft to assist in the war emergency. The original officers were George S. Patterson, President, and Sterling Newell, Secretary and Treasurer. The directors were George S. Patterson, Sterling Newell, F. S. Whitcomb, Paul J. Bickel and C. C. Owens. On October 1, 1917, the Company bought the plant of The Niles Car and Manufacturing Company, and immediately put this plant in shape for aircraft work and put up additions and added machinery, making a total expenditure for plant account alone of over \$485,000.

The first order for aircraft was received in the fall of 1917, for JN4-D spares, and the first production order started through the factory January 1, 1918. By the first of June over a million dollars' worth of these parts were delivered. In addition to this, orders were received for one thousand DH-9's, but owing to the fact that the Government was unable to furnish a complete set of prints for this machine, it substituted an order for DH-4 spares.

This order was not executed until April, 1918, thereby causing a lapse in the production, the working force dropping from over nine hundred employees to three hundred forty-five. Production had nicely started and deliveries were coming through when the Armistice was signed.

The total years' business for 1918 will probably amount to between four and five million dollars, some of which have not been delivered, due to the suspension of contracts. Facilities, at the time of the signing of the Armistice, were so shaped and brought up to such a standard, that the Company would have been able to produce twelve million dollars' worth of Airplanes for the Government during the year 1918.



H. D. SAYLE

GEO. S. PATTERSON
A. J. ENGEL

The factory covers approximately two hundred thousand square feet of floor space, and the land is, approximately, seven acres.

The officers of the Engel Company are: W. D. Sayle, President and General Manager; A. J. Engel, Vice-President and Production Manager, and Geo. S. Patterson, Secretary and Treasurer and Executive Manager.

Mr. W. D. Sayle, President of the Engel Aircraft Company, is considered one of the big and influential business men of Cleveland, Ohio, and is president of no less than six big manufacturing concerns in Cleveland and its vicinity. In addition to this, he is a director of a dozen other concerns.

He became interested in the Engel Aircraft Company on account of the war emergency, and felt that it was his patriotic duty to lend his valuable experience and assistance in order to help win the war.

Mr. A. J. Engel, Vice-President and Production Manager of the Engel Aircraft Company, is one of the pioneer Curtiss flyers, and devoted his early days to the original Curtiss exhibition team. Later, on account of the war, he was called into the Curtiss Factory, and was, finally, detailed by that organization to superintend the construction of the original Model T boat, which is the largest heavier than air flying machine ever built. It has a power plant of four twelve-cylinder, 350 H. P. Curtiss motors. It was necessary in shipping this, on account of its size, to send the hull through the Erie Canal and the Hudson River to the port from which it was shipped.

As soon as Mr. Engel's work was completed on this boat, he was sent to Spain as a representative of the Curtiss Aeroplane Company and gave the Spanish Army and Navy their first lessons in airplane work and flying.

On Mr. Engel's return from abroad, the war emergency was just confronting this country and some of his old friends and associates became interested in financing the Engel Aircraft Company, for the purpose of assisting in the war emergency.

Mr. George S. Patterson, Secretary and Treasurer and Executive Manager of the Engle Aircraft Company, is a native of Cleveland, Ohio, and is well and favorably known as one of the pioneers in the automobile industry. He is known by his intimate business associates in a number of successful enterprises, of which he has been directly responsible. His devotion to the business interests of the Engel Aircraft Company have been little short of heroic, and

through his tireless efforts it has been brought up to its present high standard of efficiency.

The Engel Aircraft Company has been engaged in the design of original machines as well as in the production of standard types for government use.

An entirely new design of flying boat has been planned and built by Mr. A. J. Engel. This boat has a Curtiss OXX-5 motor; high speed $78\frac{1}{2}$ miles per hour, landing speed of 40 miles per hour. It is a two-passenger model and carries a gasoline supply for a cruising radius of seven hours. Its wing spread is 46 foot upper and 38 foot lower wing; the upper and lower wings have three degrees sweep back. The upper plane is staggered sixteen inches and the machine has three degrees dihedral.

The hull is of stream-line shape, with very easy and graceful lines, and with double concave V-bottom. This is planked with $\frac{1}{8}$ -inch mahogany over the water line; under the water line it is planked with double $\frac{1}{8}$ -inch mahogany, and a sheet of eight ounce drilling laid in Jeffries Marine Glue between the planking. The bottom is also double planked with double $\frac{1}{4}$ -inch mahogany, interlined with drilling laid in Jeffries Marine Glue.

The Company is very much pleased with this model for the reason that in three months of experimental test flying, they have not found that a change could be made that would improve the qualities of this plane either in flying or construction.

In addition to the above model, built and flown so successfully, the Company is considering entering into the field of moderate priced flying machines and motors and have now under consideration the following models:

SINGLE MOTOR LAND OR SEA PLANE

FOR CIVILIAN, COMMERCIAL AND SPORTING PURPOSES

SPECIFICATIONS

MODEL D (Land Machine) and MODEL DS (Sea Plane)

Span, 18 feet.

Gap, 50 inches.

Length, 16 feet.

Height, 6 feet 8 inches.

Chord, 54 inches.

Engel Six-Cylinder Motor, 55-60 H. P.

Sustaining surface, 162 square feet.

Top Speed, 60 M. P. H.

Wing Curve, Eiffel 36.

Landing Speed, 30 M. P. H.

Weight, 900 pounds.

DOUBLE MOTORED LAND OR SEA PLANE

FOR CIVILIAN, COMMERCIAL AND SPORTING PURPOSES

SPECIFICATIONS

MODEL D-2 (Land Machine) and MODEL DS-2 (Sea Plane)

Span, 30 feet.	Two Engel Six Cylinder Motors, 60 H.P.
Gap, 50 inches.	Each.
Length, 18 feet.	Sustaining surface, 275 square feet.
Height, 6 feet 6 inches.	Top speed, 75 miles per hour.
Chord, 54 inches.	Wing curve, Eiffel 36.
Weight, 1,440 pounds.	Landing speed, 35 miles per hour.
	Weight, per H. P., 12 pounds.

ENGEL MOTOR FOR LIGHT WEIGHT LAND MACHINE
OR SEA PLANE

FOR CIVILIAN, COMMERCIAL AND SPORTING PURPOSES

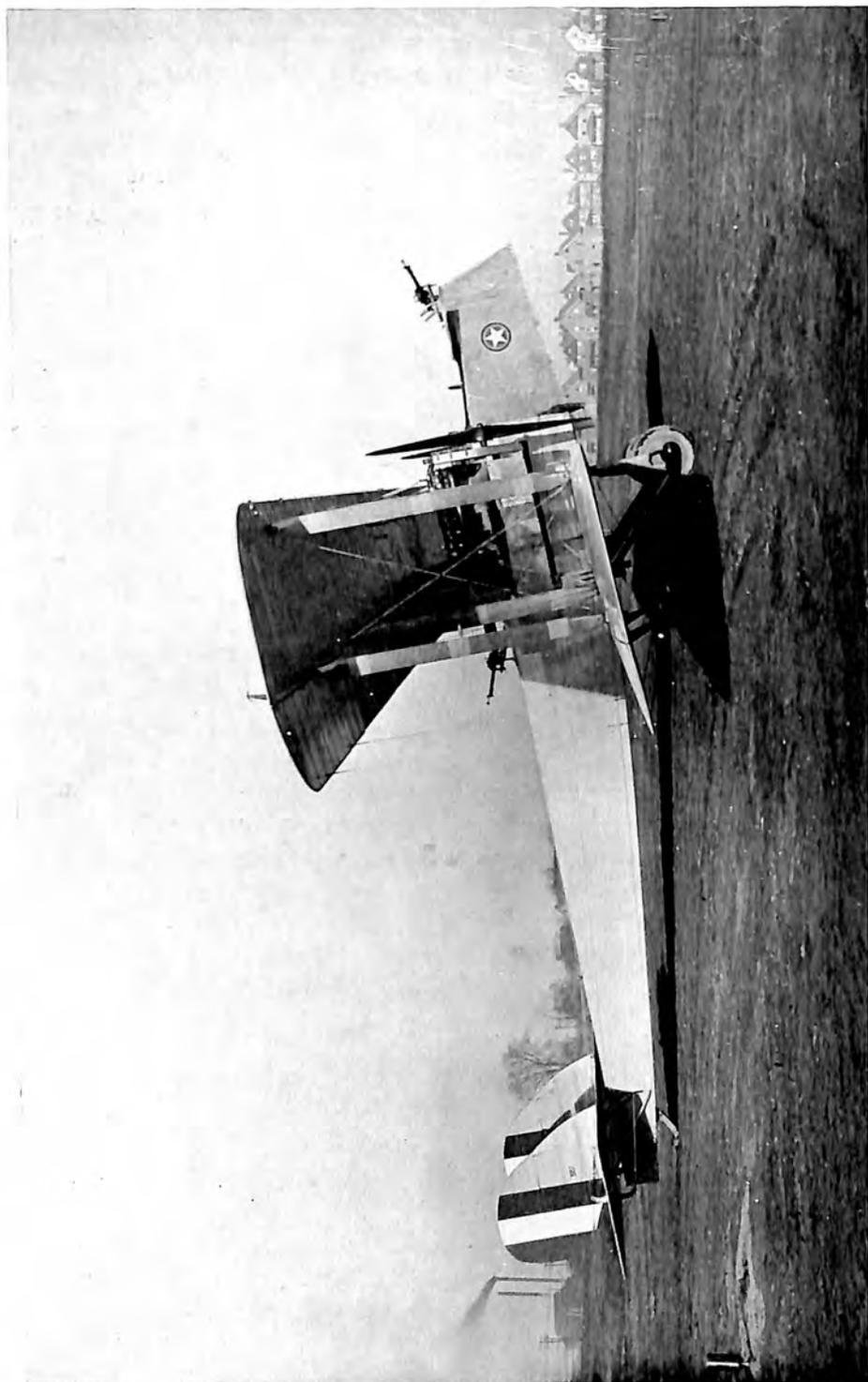
SPECIFICATIONS

Engel Motor, 55-60 H. P., at 1800 R. P. M., turning propeller at 1200 R. P. M. Upper half of crank case, cylinders and intake manifold of aluminum, cast integral.

Cylinders reinforced with cast iron sleeves; cylinder head en bloc and removable. Valves contained therein. Cam shaft mounted on cylinder head. Pistons, special aluminum alloy. Connecting rods of same alloy.

Weight, 172 pounds.

The Engel Aircraft Company are great believers in the future of aircraft, but feel, that at the present time, it is necessary for the Government to lend its assistance to this infant industry in order to conserve and protect the capital now involved, and which was placed in the business, originally, with the idea of assisting in winning the war.



A side view of the Glenn L. Martin twin-motored 800 H. P. Bomber



The Main Building, Glenn L. Martin Factory

GLENN L. MARTIN COMPANY

CLEVELAND, OHIO

GLENN L. MARTIN *President*
 CARL N. OSBORNE *Vice-President*
 W. D. TURNER *Secretary*
 S. LIVINGSTON MATHER *Treasurer*

Directors

W. G. MATHER	C. W. BINGHAM
ALVA BRADLEY	M. B. JOHNSON
GLENN L. MARTIN	CARL N. OSBORNE
W. D. TURNER	S. L. MATHER
CHARLES E. THOMPSON	

ADDRESS—16800 St. Clair Avenue.

AT seven o'clock on the evening of August 17, 1918, thousands of people were grouped about a compact modern factory building in Cleveland, Ohio. It was a quiet crowd. Four minutes later, however, the assemblage had become a wildly clamoring mob. Something had cut the skyline and soared upward with a noise audible above the cheering of those who watched it. It was the Glenn L. Martin Bomber, the first gigantic land machine of American design built in answer to the war emergency, soaring upward under the 800 H. P. of its two Liberty motors.

The ascending machine was the concrete evidence of the Glenn L. Martin Company's successful war effort. Mr. Martin, one of the oldest American pilots and aircraft producers, had organized the new corporation in the fall of 1917 with the idea of creating an American machine which would carry a new strength to European battle fronts. The Government requested the Martin organization to develop a plane around twin Liberty motors, and the flight which was watched from the streets and windows of Cleveland was the result.

Twenty-three minutes after he had left the ground, Pilot Eric Springer brought the new machine smoothly to rest on the field,



Main Building of the Glenn L. Martin Company Factory under construction, March 13, 1918

and the performance of the Bomber was disclosed. "The best job I've ever flown," commented the pilot. He had ascended to a height of 9,000 feet, developed a speed approaching 120 miles an hour, and proved to his satisfaction that the plane would fly securely under the power of either one of its two motors. Subsequently the mammoth airplane was to be given officially a ceiling of 16,000 feet, a speed of 118.5 miles with full load, and an ability to climb to an altitude of 3,000 feet under the power of one engine. It was a record which no previous *corps d' armee* bomber had approached.

The first Martin Bomber had flown in August, 1918. In February, 1918 the drawings for the new "ship" were barely started. There was no Glenn L. Martin factory at Cleveland. The Martin workers were being drawn together, and had not yet been organized as an industrial unit. In six months the present Clair Avenue factory had been erected, and had turned out a complete machine.

The achievement may be explained only by explaining the Glenn L. Martin Company. As a corporation it dates from its organization for patriotic purposes of aircraft development in the fall of 1917. But as a group of workers it goes back to the early days of the aeronautical industry. Mr. Martin had become interested in airplanes in 1909. In that year he built and flew his first machine at Santa Anna, California. The small pusher, with a 30 H. P. Eldridge motor which the inventor had to learn to fly himself, led him first into further experiments in design, and then into the establishment of one of the oldest airplane companies in the United States at Los Angeles, California. Here a corps of expert airplane mechanics was trained.

Many of these came from the Pacific Coast to Cleveland when the Glenn L. Martin Company began operations in 1918. Many aircraft companies had experienced aeronautical engineers. Not



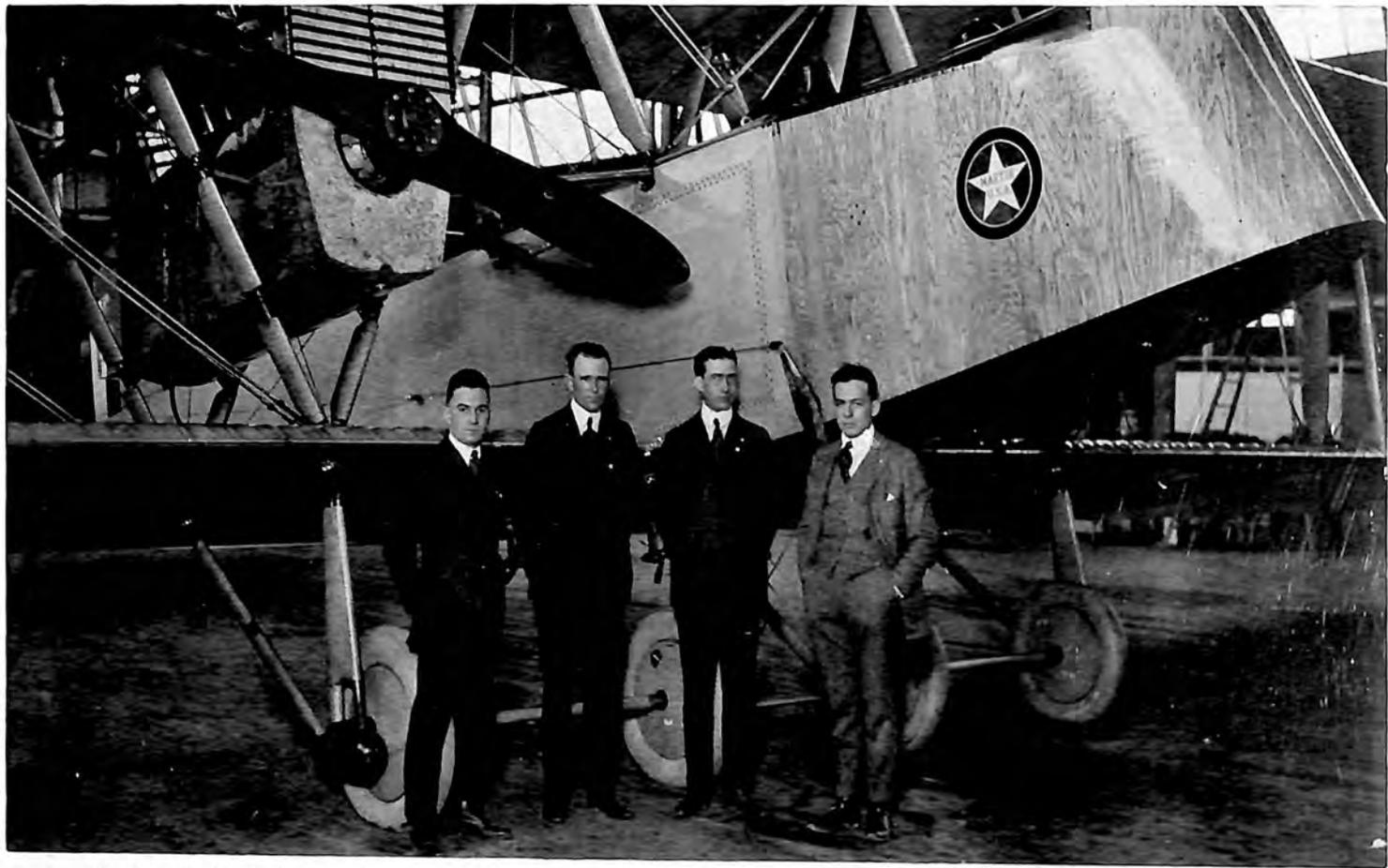
The Main Building just before completion, March 30, 1918

many had a force from president to plain mechanic drilled from the beginning of the industry in the task of aircraft production. It was this essentially veteran company which made a success of the technically new one.

The record of the Glenn L. Martin Company of Los Angeles, however, need not be given in detail as a part of the history of the present company. It is enough to say that its work, dating from 1910, was of international repute two years later, Martin products going to Japan, Java, and various parts of the United States. By 1912 the twenty-six-year-old proprietor had begun to gather members of his present force, including Laurence D. Bell, now factory manager. He had organized a flying school, and from this time on he began the production of standard machines which had a substantial success. The Martin Tractor came out in 1912. Model TT, used in 1913-14 by the Government, and, in hydroaeroplane form, a winner of the Curtiss marine trophy for covering the highest number of miles in a day, was a leading type of its time. The S C plane, developed in 1915 and used by the Government in the Philippine service and for coast patrol, the TA hydroaeroplane (1914) used for Government training, and by the Dutch East Indian Government of Java; the 1916 Model R, employed at Kelly Field in 1917, are equally noted as early Martin designs.

The planning and production of these machines had developed an efficient working organization. One of its members was a young graduate of the Massachusetts Institute of Technology, who had joined the company in 1915. In 1916 Donald W. Douglas had left the Martin Company of Los Angeles to serve the Government as aeronautical engineer, but soon after the organization of the present company he rejoined Mr. Martin and began work upon the Bomber.

Fortunately for the designer of the Bomber and the company as



The Glenn L. Martin Company Executive Officers. From left to right: Laurence D. Bell, Eric Springer, Glenn L. Martin, and Donald S. Douglas



The Bomber, Front View

a whole the Government extended the new organization a surprising freedom. The Glenn L. Martin Company suggested to the United States Government that it be given full authority with regard to specifications. It offered as a guarantee of satisfactory work its experienced working force, and this was accepted as satisfactory by the Government. Nor would the company agree to meet a definite performance. It would simply engage to do the best work it could. This condition was also accepted by the Federal authorities.

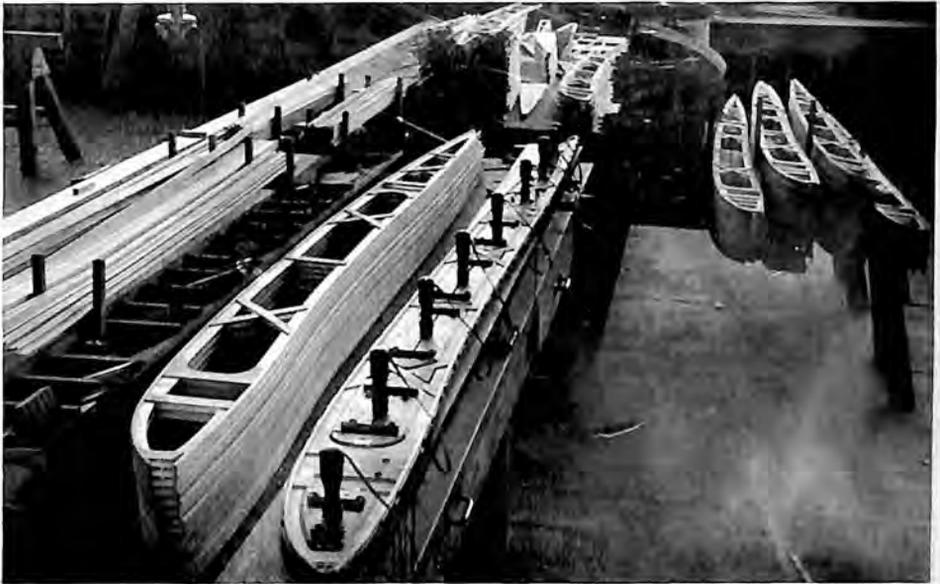
The performance of the completed machine has already been noted with respect to certain features, but it will be appropriate to indicate in detail the exact nature of the Bomber, and the causes for its success as a design.

The new aeroplane had no characteristics of a revolutionary nature with regard to general lines. In another sense, however, it was startlingly original. It seized the supposed weakness of the American aircraft industry—quantity production—and rode it to success.

Quantity production, to justify itself, must represent the refinement of a number of processes to the Nth degree of efficiency. This was throughout characteristic of work on the first American bomber. Waste was eliminated everywhere. Past designs were simplified and strengthened. A great saving in weight and bulk was the result. The wing ribs and struts represent the former, the nacelles which



Another view of the Bomber



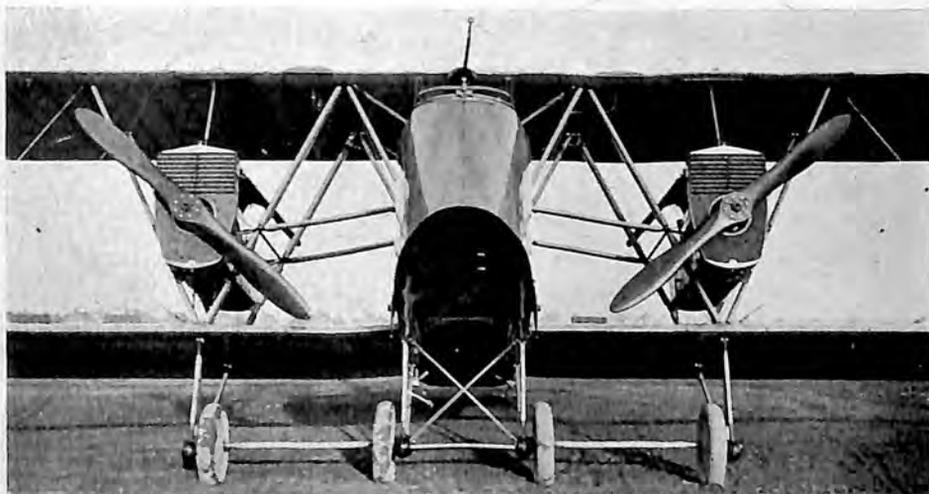
The Wing Rib Jig of the Martin Company

hold the engines the latter. The wing ribs, for instance, are built in a special jig which works from the outside in. Bound by the same metal frame, the contour of every rib must tally to .010 of an inch. At the same time efficient study of rib structure, and the fact that the parts could be fitted in the jig accurately before being nailed, enabled the company to save weight on every one of the 185 ribs going into its machine.

The struts, too, represented a refinement of past practice. All struts had hitherto been made solid. The Martin process makes



The Jig in Operation



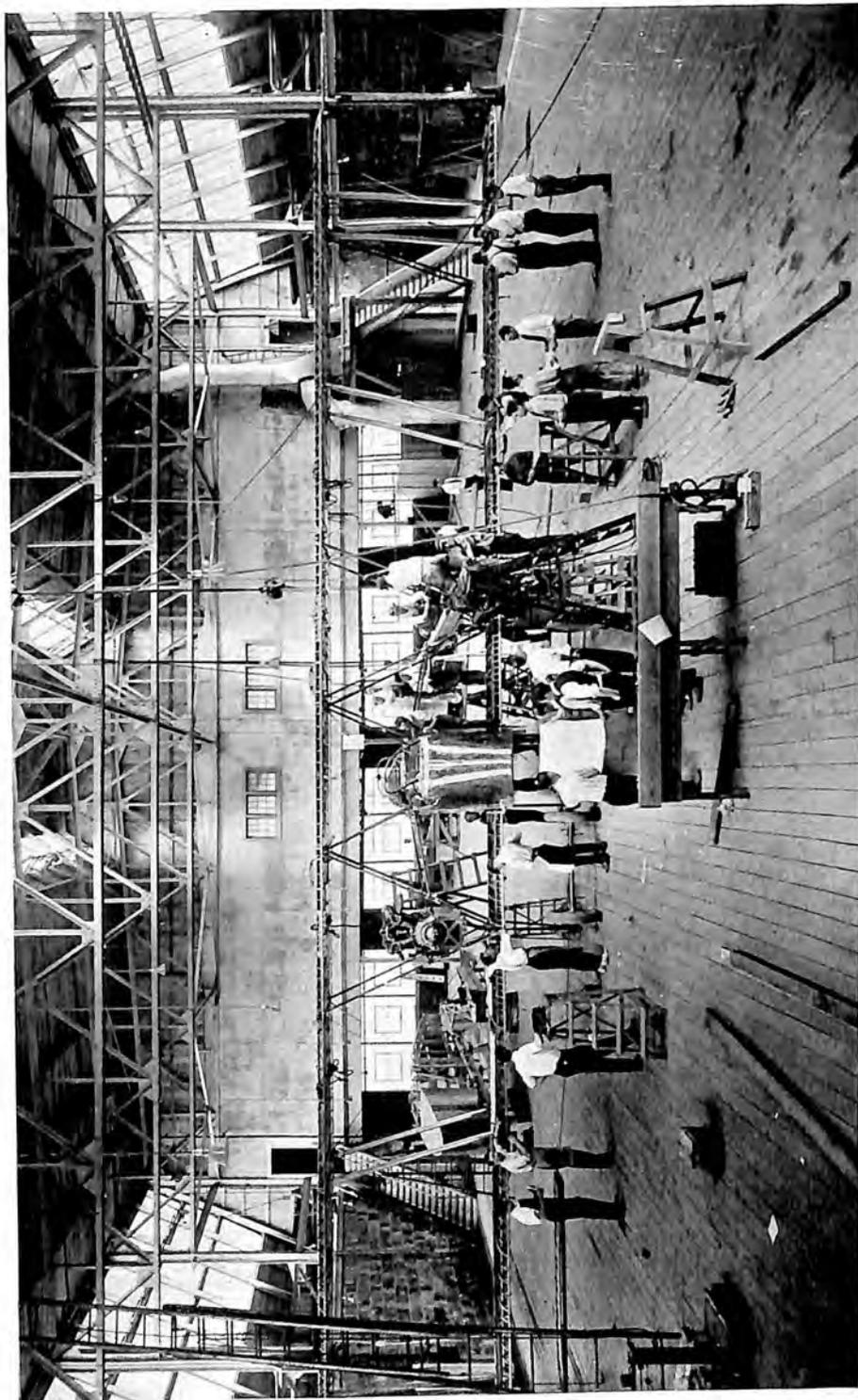
The two Liberty Motors which constitute the power plant of the Bomber as they appear from the front

the strut in two pieces, and hollow struts are the result, weighing less than solid ones, and, by the principle of lamination, at the same time achieving great strength.

These devices cut down greatly the total weight to be lifted. At the same time they permitted a factor of safety of 8 throughout. The nacelles, on the other hand, represented sheer elimination. These supports for the power plants are far smaller than those of earlier European bombers. These instances are typical of methods pushed to the extreme throughout the entire airplane. The result was quantity production. But the specialized processes and modern machinery used turned the supposed American defect into an



The tail surfaces of the Martin Bomber



Putting the big "ship" together in the Assembly Room



A part of the Metal Department

advantage. Europe had made fine hand work its boast. Quantity production, it claimed, could not meet the fine working demands of airplane construction. America devised machinery of a fineness which hand work could not approach. Its ribs came out matching to the shadow of an inch. Handwork could hope for nothing so accurate, and the Martin Bomber was the last word on the application of the great American method to an aeroplane.

The completed Bomber had a wing spread of 71 feet 5 inches. It carried a supporting surface of 1,070 square feet. In length it measured 45 feet, in height 14 feet.

It climbed, fully loaded, to 10,000 feet in 15 minutes, and reached a ceiling of between 16,000 and 17,000 feet. It could carry a load of 1,500 pounds of bombs and 1,000 rounds of ammunition, enough gasoline to last six hours at 15,000 feet, or for a cruise of 600 miles, from three to five machine guns and a 37 mm. semi-flexible cannon. The armament allowed fire at an enemy in any conceivable position. There is no "blind spot" for the Glenn L. Martin Bomber.

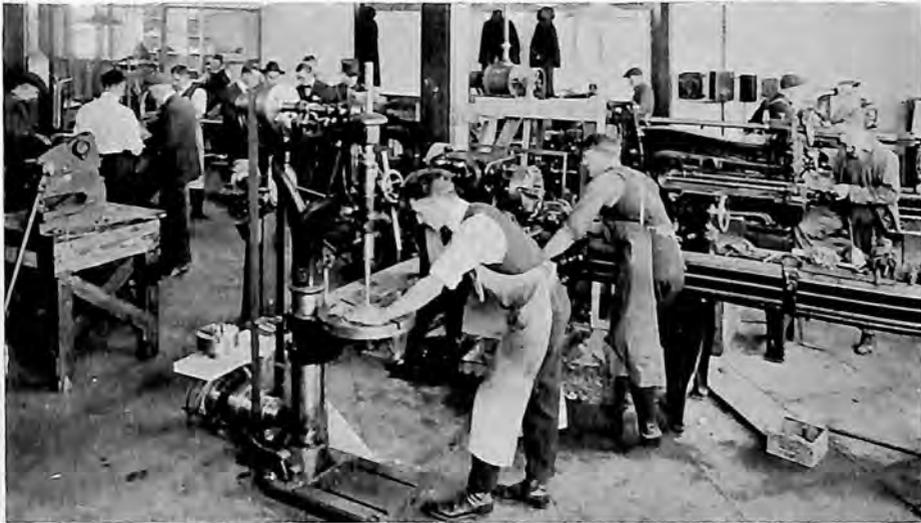
When the machine was designed, the question of peace use was considered from the beginning, and a design was achieved which was easily adaptable to the commercial uses which the world now plans with respect to the airplane.

Mail and express carrying, transportation of passengers, freight transport, and aerial map and survey work are practicable for the Bomber. Eleven passengers, in addition to the pilot, can be carried by a shifting of the gasoline tanks, or a load of mail or ore of over a ton can be substituted.

The success of the bomber as a war machine was shown by its being one of the machines of entirely American design to go on the 1919 fighting program of the Government. The Department of



The Mill of the Glenn L. Martin factory



One end of the Machine Shop in the temporary quarters at 950 Chestnut St., Cleveland, in the spring of 1918

Military Aeronautics is using the Bomber for various training purposes, and is equipping it for all peace purposes, such as forest, border, and coast survey, etc. Not the least of the future functions of the machine will be mail and express carrying. Its twin engines make it practically independent of power plant trouble, and its high speed and ability to rise in 200 feet and land in the space required for an ordinary training machine make it highly valuable. A number of economies and conveniences, such as the special control system, the arrangement of the instrumental board, etc., cannot be noted in detail.

Every machine depends for its quality upon the conditions which govern its production, and the story of the Bomber and its company cannot be told without telling of the Glenn L. Martin factory. The present plant succeeded the temporary quarters, which were established at 950 Chestnut Avenue, Cleveland. Work was begun upon it in March, and forty-five days after the first ground was broken building was completed.

The plant is a single structure of 300 x 200 feet. It is divided into three equal bays or sections. The two outer bays of 100 x 200 feet are supported in the center by columns, but the floor of the center section, of the same dimensions, is free from supports. It thus gives ample room for the assembly of the complete machine and of the fuselage parts to be carried on without difficulty.



The Engineering Offices

The East bay contains the Mill, the Cabinet Shop, the Wing Assembly, Dope, and Cloth Departments. The west section comprises the Machine Shop, Stock Room, and Inspection Department. The executive offices run along the front of the building.

The entire plant has an estimated capacity of two complete Bombers per week. It was about to be greatly extended for larger production when the armistice halted its war projects.

The efficient plan of the building is supplemented by the most modern machinery and processes. Mr. Martin and his staff are on an eternal hunt for efficiency. For instance, there is the Planning Department. It plans and times all operations so as to co-ordinate effort, eliminating unnecessary delay and friction. The inspection system is likewise particularly efficient. Inspection begins with raw materials, comprises the chemical analysis of metals, physical tests on wood samples, etc. Operation is watched, and inferior workmanship immediately detected and scrapped. The factory staff is composed of Glenn L. Martin, general manager; Laurence D. Bell, factory manager; Donald W. Douglas, chief engineer, and Eric Springer, pilot.

The company has made a part of its efficiency the improvement of working and living conditions for its employees. A cafeteria serves meals at cost to Martin workers, and a night school, offering business training and aeronautical engineering courses, has been attended by 60 per cent of the working force.

The immediate work of the Glenn L. Martin Company will consist of the completion of Government contracts for the Bomber, and its adaptation to peace purposes. The commercial future of the machine is promising. Inquiries have been made by mine owners

and oil producers concerning its employment as a freighter. Interesting calculations have been completed favorable to its practicality for passenger carrying. It is immediately available for carrying mail, having a full ton capacity. Extensions of its gas supply would make trans-Atlantic travel possible.

The company has concentrated upon the one type, but it is planning a machine of larger size, and is at the same time developing certain auxiliary features which will be of use in both models. One of these is the Martin Parachute Safety Pack. This device, a parachute enclosed in a package and weighing, complete, only six pounds, permits parachute descent from an aeroplane travelling at the rate of 120 miles per hour. The invention has been in development since 1912. Last fall it met tests at Dayton successfully. Another Martin activity is the development of radio devices. Mr. F. S. McCullough, radio engineer, has conducted successful experiments in devising a radio compass—an instrument which will show the direction from which messages come, and enable a machine to be guided by them to any point. Much has also been done with the wireless telephone.

While it has been pushing the design of aeronautical essentials and auxiliaries, the company has not neglected to consider the conditions governing the possible uses of these. A thorough investigation of the costs and utility of commercial flying has been one of its recent activities. It has satisfied itself of the practicability of the Martin Bomber as a peace-time aeroplane. At the same time it has the satisfaction of knowing that one design of the machine permits a shift of all Martin machines from peace to war as from war to peace, and that any emergency will find the company product an asset for defense as well as an efficient instrument of commerce.





The Final Assembly Room, L-W-F plant



Model G, the first L-W-F Plane which flew with the Liberty 12-Cylinder Motor

L-W-F ENGINEERING COMPANY, INC.

COLLEGE POINT, L. I., N. Y.

J. M. FITZGERALD *President*
 A. H. FLINT *Vice-President and General Manager*
 W. N. BENNETT *Secretary and Treasurer*

Directors

J. M. FITZGERALD BRADLEY W. FENN
 A. H. FLINT E. C. WHITBECK

PARKER SLOANE

PLANT—College Point, L. I.

A BUSINESS is like a model city—it can be built better if you build it complete than if you patch along from one stage of it to another. And a good thing about the war from the standpoint of airplane manufacturing was that it gave business men an opportunity to build complete and from the foundation up. Perhaps no company represents so well what the war brought to the United States aeronautical industry as the L-W-F Engineering Company, Inc.

It sprang from the experimental to the practical stage in a day. And in preparing itself for war work it produced an equipment, which is to the average factory as the ideal city is to the actual one. Every



The first L-W-F Machine, equipped with Pontoons

building at the College Point, Long Island plant, was constructed especially for the work which goes on within it. Every process used represents a study of best methods. The result has been durability and beauty in aircraft products, but more important, an aeronautical factory not adapted from a dye works or a foundry, but erected through and through for the making of airplanes.

The L-W-F Engineering Company was organized in December, 1915, its chief asset the laminated wood monocoque fuselage machine which has carried the present company's name to such widely-separated places as Texas and the Czecho-Slavic front. The officers of the corporation are: J. M. Fitzgerald, President; Albert H. Flint, Vice-President and General Manager, and W. N. Bennett, Secretary and Treasurer.

When the recent war can be viewed in proper perspective, the Liberty motor will emerge as a fact from the rumor and speculation which now largely surround it. And when its history is told, the L-W-F Engineering Company will have part therein. It will be remembered that the chief engineering talent of the country gathered in Washington in May, 1917, to consider the design and production of a motor larger and more powerful than any existing at that time in this country. The well-known Liberty motor was agreed upon in a remarkably short period of time, and experimentation with it was begun at once.



The same Machine after the hurricane. The fuselage, it will be seen, is still in good condition

The original motor was an eight-cylinder type, developing from 250 to 300 horse power. Every motor requires a plane especially adapted for its use. In most cases an especially designed plane must be built. There were no planes in the United States suitable for the immediate installation of this motor, and no manufacturers, with one exception, were ready to guarantee a suitable plane in less than sixty days. The L-W-F Engineering Company agreed, however, to mount this motor in a plane adapted for it, and to have it ready for flying within ten days of the receipt of the motor. A wooden model dummy engine was to be used until the motor was received. The Company entered a formal contract to build the plane. Its compensation was set at \$1. The delivery was to be in ten days.

The resultant plane, delivered in nine days, was known as the L-W-F Model F. One of its chief features was the laminated monocoque fuselage. This, with a sturdy military chassis, enabled the machine to mount the new motor, although the power of previous motors used in it had been about half that anticipated from the Liberty. On the 21st of August, 1917, the new motor in its adapted plane was flown successfully for the first time. The results were gratifying. The machine reached an altitude of 7,000 feet in the first ten minutes, and a 19,000 feet ceiling at the end of fourteen minutes. It proved faster than the Nieuport Speed Scout then at Mineola, one of the fastest European planes of its day.



An L-W-F Fuselage for Model V. Note the twenty men which the shell supports

The new machine was shipped to McCook Field at Dayton, Ohio, for further tests. Here it developed a speed of 120 miles an hour. It compared favorably with the best foreign planes. The Signal Corps decided to build the Liberty 12 developing 400 horse power instead of the eight-cylinder type, and work was begun upon a plane to mount this larger engine.

Model F was of the military reconnaissance tractor type of biplane, and carried a load of two men, fuel and oil for four hours, and special military equipment. The span of the upper wings was forty-six feet; that of the lower wings thirty-eight feet. The chord was seventy-five inches.

The plane which carried the first Liberty motor was an adaptation of the first machine which the L-W-F Engineering Company had produced. This early or V type was first flown in June, 1916. At that time, it was considered the fastest machine in America. Its strong landing gear and its monocoque fuselage of the Company's special construction gave it remarkable strength and endurance. The landing gear of L-W-F machines has never been smashed, and the body lends itself to repair in a way which the linen and wood combinations usually seen on flying fields cannot begin to parallel. The speed of this first type ranged from forty-five to ninety-three miles per hour. Its weight, when fully loaded, was 2,500 pounds, and it had a climb of 350 feet per minute. It has been used for advanced



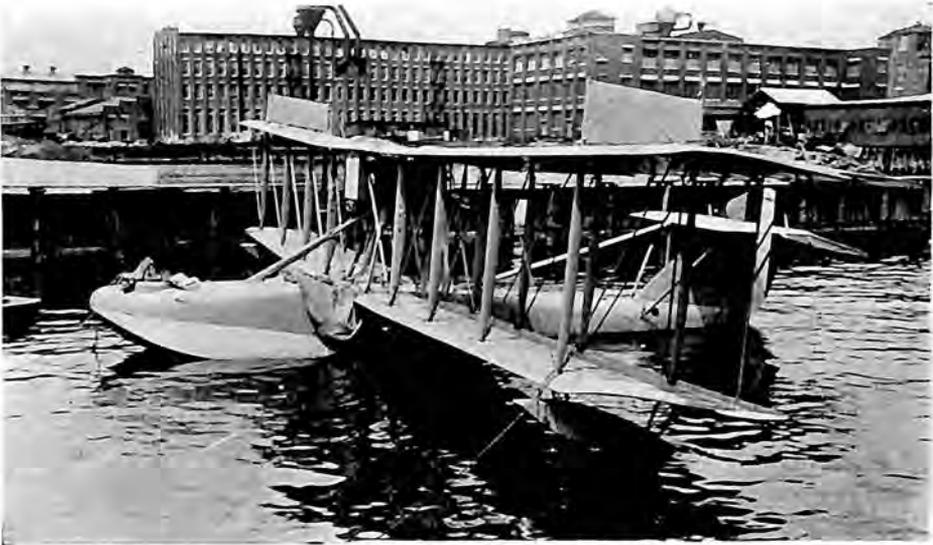
An HS-2-L Flying Boat taxiing across Flushing Bay

training in the United States, in France and on the Czecho-Slavic front in Russia.

The first machine was sold to the Michigan State Militia. Pontoons were supplied, interchanging with the wheels and undercarriage. Unfortunately, the airplane broke from its moorings during a hurricane on Lake St. Clair and was completely demolished except for the fuselage. This, although it had undergone a severe pounding and had been under water for ten hours, was barely damaged.

During 1917 a number of models were built of a design similar to the first, and various motors were used on them. The 135 horse power Sturtevant, the 210 horse power Sturtevant, the 125 horse power Hall-Scott, and the 145 horse power Thomas were all employed.

The new L-W-F plane, mounting the Liberty 12 motor, was called the Model G. It carried a load of 2,200 pounds, including military equipment, in addition to its own weight of 2,675 pounds. It reached an altitude of 10,000 feet in nine and a quarter minutes, and developed a speed range of from fifty miles an hour to one hundred and thirty-four miles per hour, with armor, seven machine guns, four large bombs, 135 gallons of fuel, an adequate supply for four hours' flying. One unique feature of its armament was a gun mounted to fire through a hole in the lower rear of the fuselage for protection against an attack from beneath the tail of the machine. The airplane was camouflaged by being painted sky blue below and earth brown above.



An HS-2-L type moored to the bulkhead built at the L-W-F Plant on Flushing Bay

L-W-F machines were used for advanced training, both in the United States and in France. They hold an international record for an endurance flight. Driven by a 135 H. P. Sturtevant motor, a machine of L-W-F design, ascended on March 27, 1918, and remained aloft in the vicinity of San Antonio, Texas, for nine hours and fifty-three minutes. It also holds the record for speed in flight of over 1,000 miles, having averaged 138.4 miles per hour in a flight of 1,357 miles.

Orders for training machines which the Government placed with the L-W-F Engineering Company were supplemented in the fall of 1917 by a contract for large flying boats for the United States Navy. The production of these proceeded slowly on account of multitudinous changes in design which the Government thought advisable to make. But by July, 1918, production was well under way, and at the cessation of hostilities no factory was turning out more work with respect to its capacity than the up-to-date plant at College Point.

To understand the war achievement of the corporation it is necessary to know what this factory represents in aircraft production equipment.

The L-W-F plant has a total floor space of 250,000 square feet. Its buildings include the assembly, the experimental, the metal, the mill, and the "dope" buildings. There are several small structures, including the garage, storehouses, guardhouse, boiler house, etc.



The Launching Ways at the L-W-F Plant, with an HS-2-L boat about to take to the water

The L-W-F plant moved from Long Island City to its present site at College Point during the summer of 1916. In the fall of 1917, the Company took over the property of an adjacent factory, which had been gutted by fire. New buildings were erected upon this site, and upon filled-in land on Flushing Bay.

As has been said, each building was definitely designed for the work which was to go on within it, and the machinery installed and the processes used were all as up-to-date as possible. The equipment of each department is exceptionally complete and the entire plant, with the exception of the motor and radiator, is manufactured in the L-W-F plant.

The L-W-F fuselage is of the monocoque type. Monocoque means "one shell," referring to the body being constructed in a unit in contrast to the usual box or girder construction. The shell is made as follows: A layer of muslin is fitted over a streamline-shaped mold. Three layers of one sixteenth inch spruce are laid on the linen, tape being wound spirally from tail to nose between the middle, inner, and outer layers. The two inner laminations are spiralled in opposite directions, while the outer lamination runs straight fore and aft. The three laminations and the two layers of tape are laid in hot glue. The outside is then covered with linen, doped on and enameled, making the complete shell approximately one-fourth of an inch thick. This type of fuselage requires no

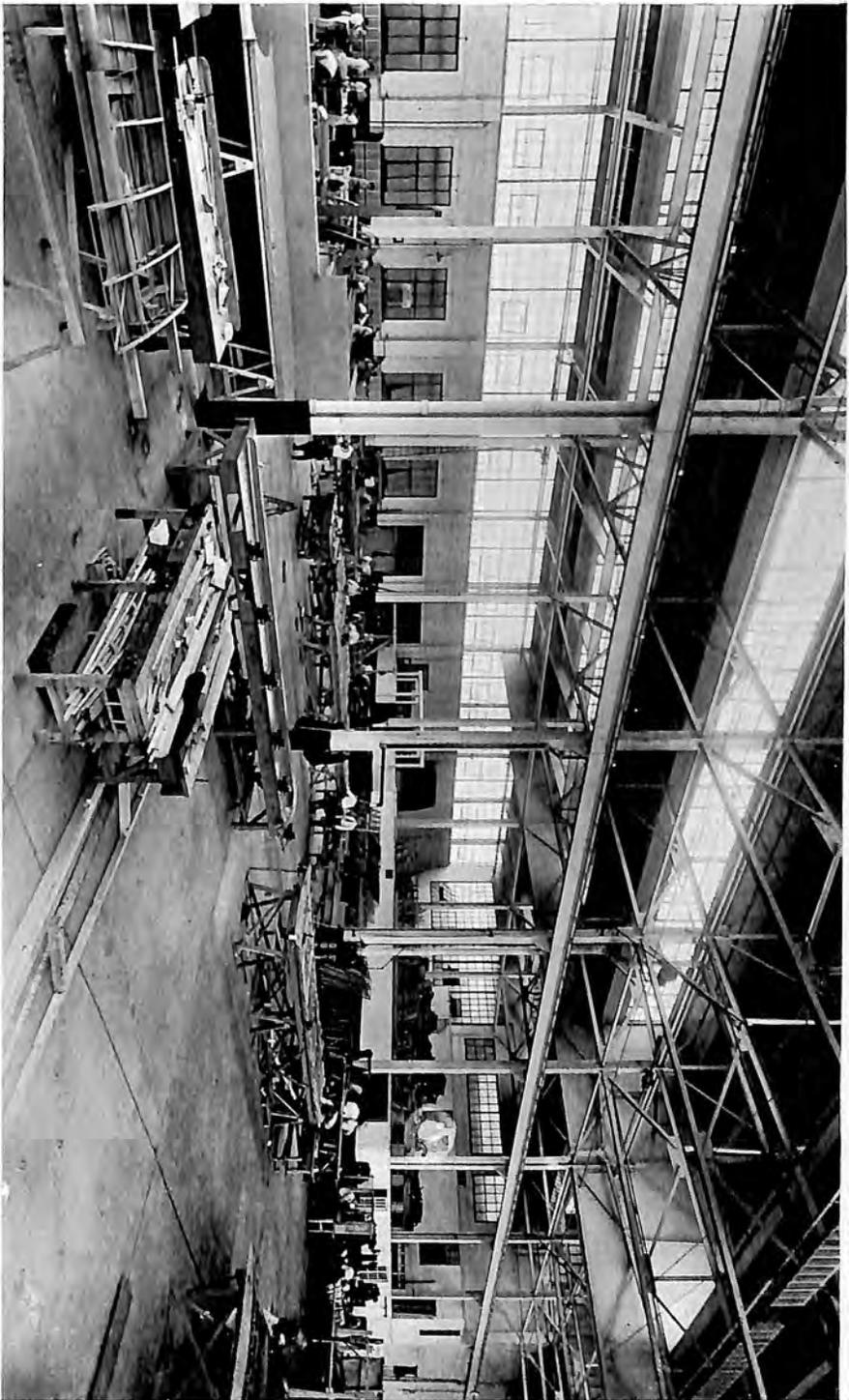


The Gluing and Steam-Bending Department

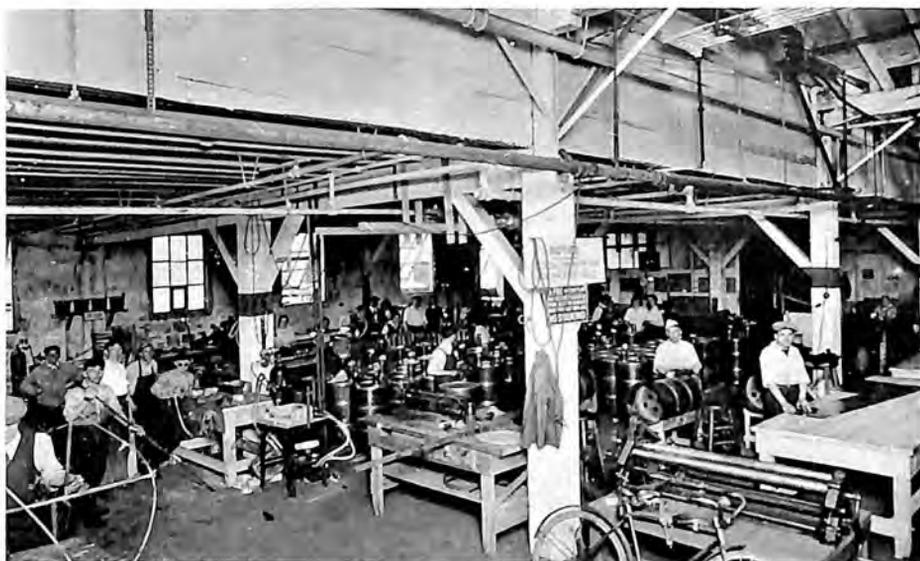
bracing except for the motor beds, the wings and the tail skid connections. It is remarkably light in weight, and has a strength and endurance unapproached by other types of construction. In a sand-load test made after the installation of the first Liberty motor, the fuselage, according to official record, stood up satisfactorily under a load of 13,000 pounds with a tail load of fifty-five pounds to the square foot.

The steam bending and gluing room contains steam retorts for preparing wood, and special apparatus for mixing and heating glue. The wood is left four hours in the steam retort and then put in a jig and bent to form. It is thus formed to the shape of the airplane. Here also laminated beams, struts, and other parts are glued together in the presses, and the fuselage is built. An even temperature is maintained at all times to insure proper drying conditions.

The wing-assembling department assembles the thousands of elements which go to form the lifting surfaces of a machine. Jigs are used for every operation. The wing is composed of a structure of wood—two beams or “spars” running its length and “ribs” running at right angles to the spars. Each rib is an intricate piece of work, and its assembly a little art in itself. As for the beams, when it is realized that they are twenty-three feet in length and must be held by jigs for the assembling process, some idea of the magnitude as well as the delicacy of the task can be obtained. The working



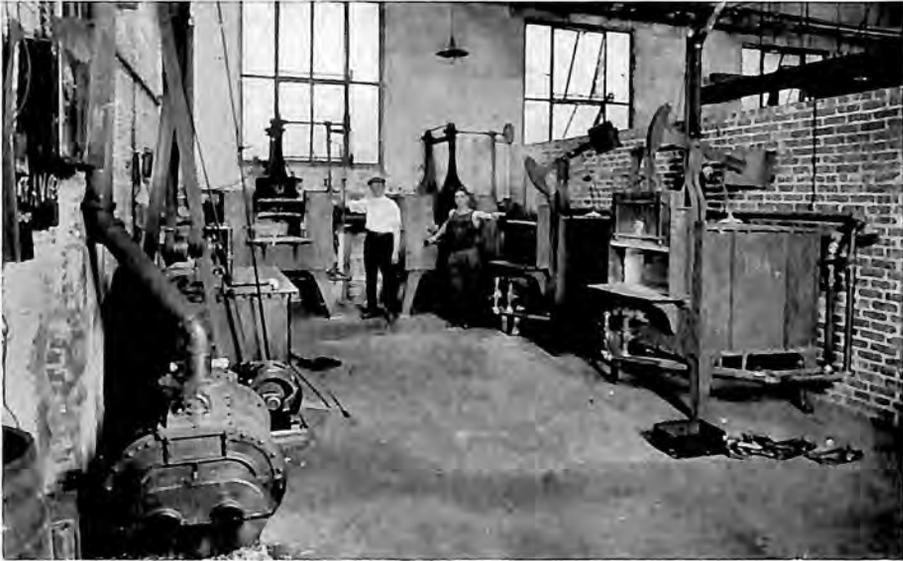
The Wing Wiring Department



The Tank Department



The Wing-Building Department



Heat-Treating Room

limits are very close and the inspection for grain, workmanship and finish is very rigid.

In the machine shop, which has dimensions of 250 by 500 feet, all classes of metal work are done. Ninety-five per cent of the metal parts for the machine have been made in the factory, and only the desire to expedite certain orders has prevented the metal fittings of L-W-F machines from being entirely composed of work turned out by the Company itself. An exception is made in the case of the motor and radiator. In the machine shop there is a heat-treating room for heat treatment of all metal parts in which any temperature can be maintained within ten degrees; punch presses, lathes and complete up-to-date equipment for making any part of a plane from a gasoline tank to a carburetor.

Another interesting feature of the plant, which concerns metal parts, is the electroplating department. This is exceptionally complete, having facilities for nickel, brass and copper plating, as well as for galvanizing and gun-metal finishing. The equipment here includes buffing machines, special barrell tumblers, and a sand blast.

The L-W-F wood mill is a study in modern factory achievement. It is complete for doing rough or fine work on various kinds of wood. Many aircraft factories merely assemble purchased parts of machines. The L-W-F Company does its own work. Thousands of



The Dry Kilns

dollars have been spent on jigs and other machinery for turning out and treating the wood members of the airplane, and work that is done in Europe by hand has been turned out by machinery so accurately that any L-W-F airplane member, such as a strut, wing rib, etc., may be interchanged with a similar part in any L-W-F model. A part of the mill is the dry kilns department in which all lumber is seasoned before use.

When the body and wings have been built, they are sent to the dope and varnishing departments for finishing. Dope is a preparation put on the supporting surfaces of a plane to fill the pores in the cotton or linen fabric, and to shrink the fabric tight on its wooden frames. The L-W-F dope room is an excellent example of the efficiency of this plant. The dope fumes are dangerous, and great difficulty is experienced usually, especially in the summer time, in getting adequate ventilation. The L-W-F dope room has a double ventilation—windows above and outlets in the floor below. The latter feature is especially advantageous, as the fumes of the dope used are heavier than air and sink to the floor, from which forced ventilation conveys them to the outer air.

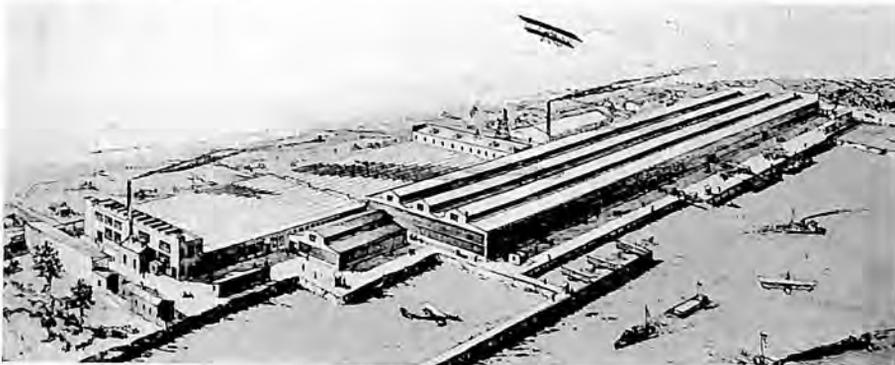
Perhaps there is no more picturesque feature of the plant than the assembly room with its 100,000 square feet of floor space. It is a beautiful sight—a long high-ceiling structure about 125 by 750 feet of steel and concrete, both sides and one end composed entirely

of windows. On its floor one hundred large flying boats can be assembled at once—the equivalent of about three hundred speed scouts. To this room the completed bodies, wings, tailpieces, etc., go, and the machines are set up complete. Planes are then flown to their destination, or crated for delivery by rail.

In case a flying boat is to be delivered at a base within flying distance or in case any test is desired, it can be rolled from the assembly room to the water—not fifty yards away. Special facilities for launching and bringing in flying boats or hydro-aeroplanes have been prepared by the Company.

The question asked of the aircraft company to-day is, "What are you going to do?" It is doubtful if any firm can guess its own future. That aerial commerce will be a decided element in it, however, seems one fact that men can build on. The most noteworthy thing with respect to the L-W-F is its thorough equipment for future developments and commerce.

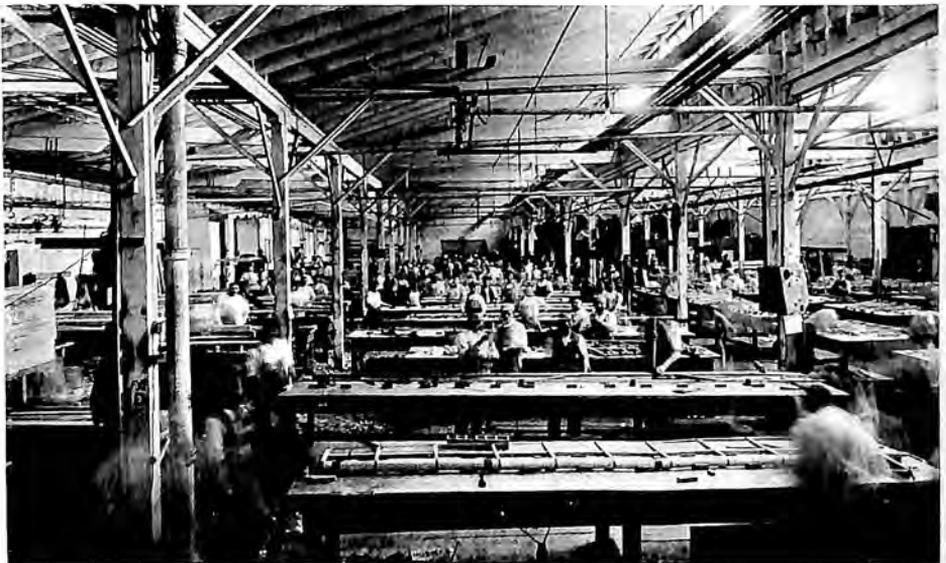
Not only has it a plant completely equipped for aircraft manufacture, but it has a staff of workers whose preparation fits them to go forward with the new industry. Mr. A. G. Flachbar, Superintendent, has had experience as a student and manufacturer of propellers, and in the production of entire machines. He designed the propeller used with the Liberty 12 engine in the Model G plane. Mr. R. J. Hoffmann and Mr. Glenn D. Mitchell, the company's engineers, have long been associated with aeronautical designing, Mr. Hoffmann in Europe as well as in the United States. Mr. Mitchell was responsible for part of the designs of models F and G. Mr. Hoffmann has had experience in connection with such flyers as Legagneux, once holder of the world's altitude record, and such builders as Etrich.



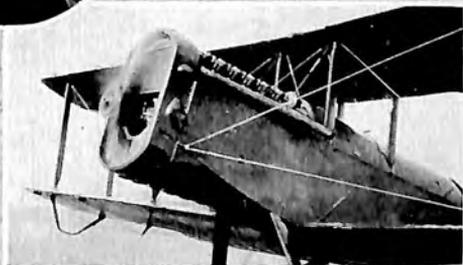
Plan of the L-W-F Plant



A corner of the Metal Department



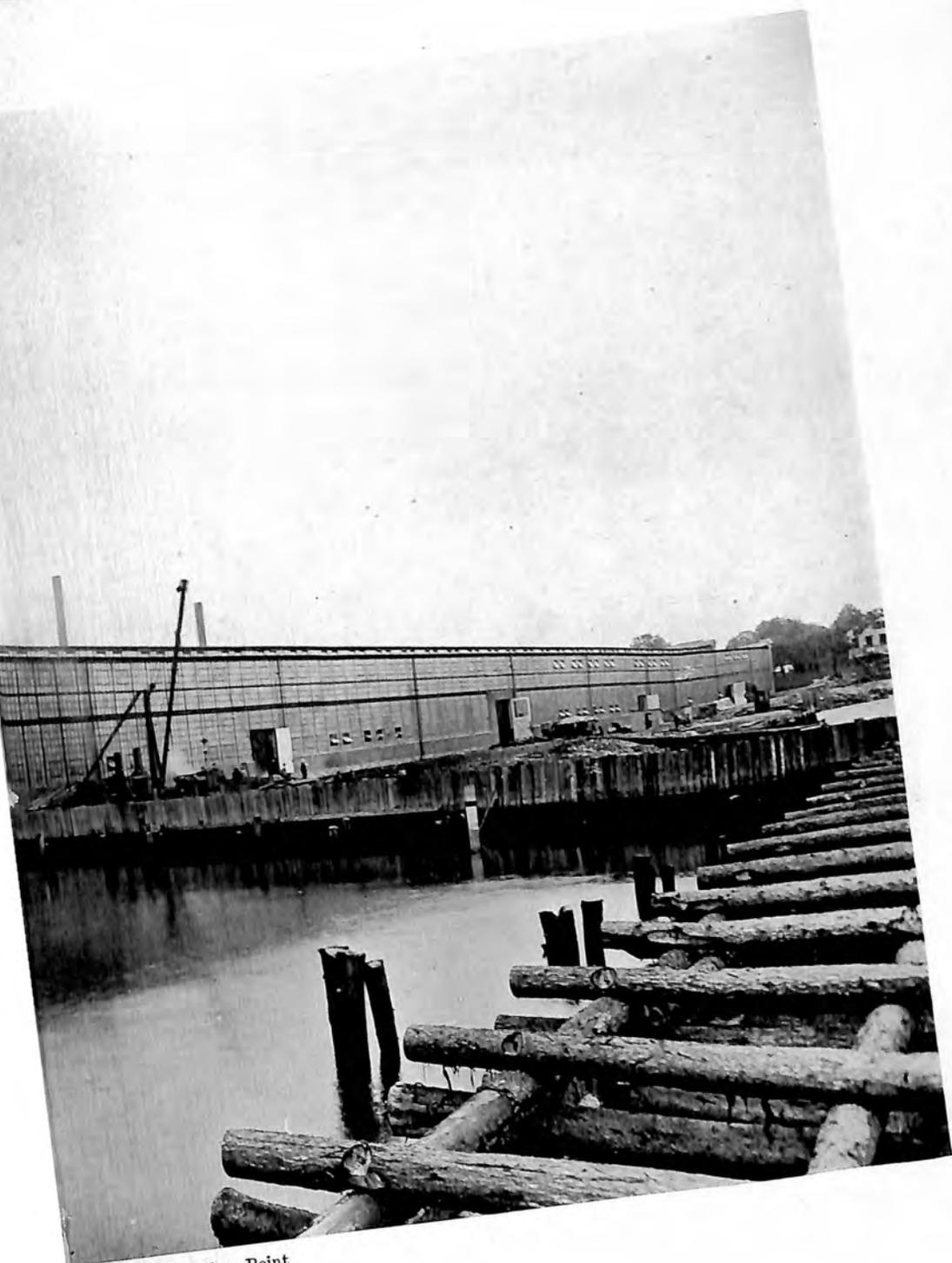
The Miscellaneous Wood Department



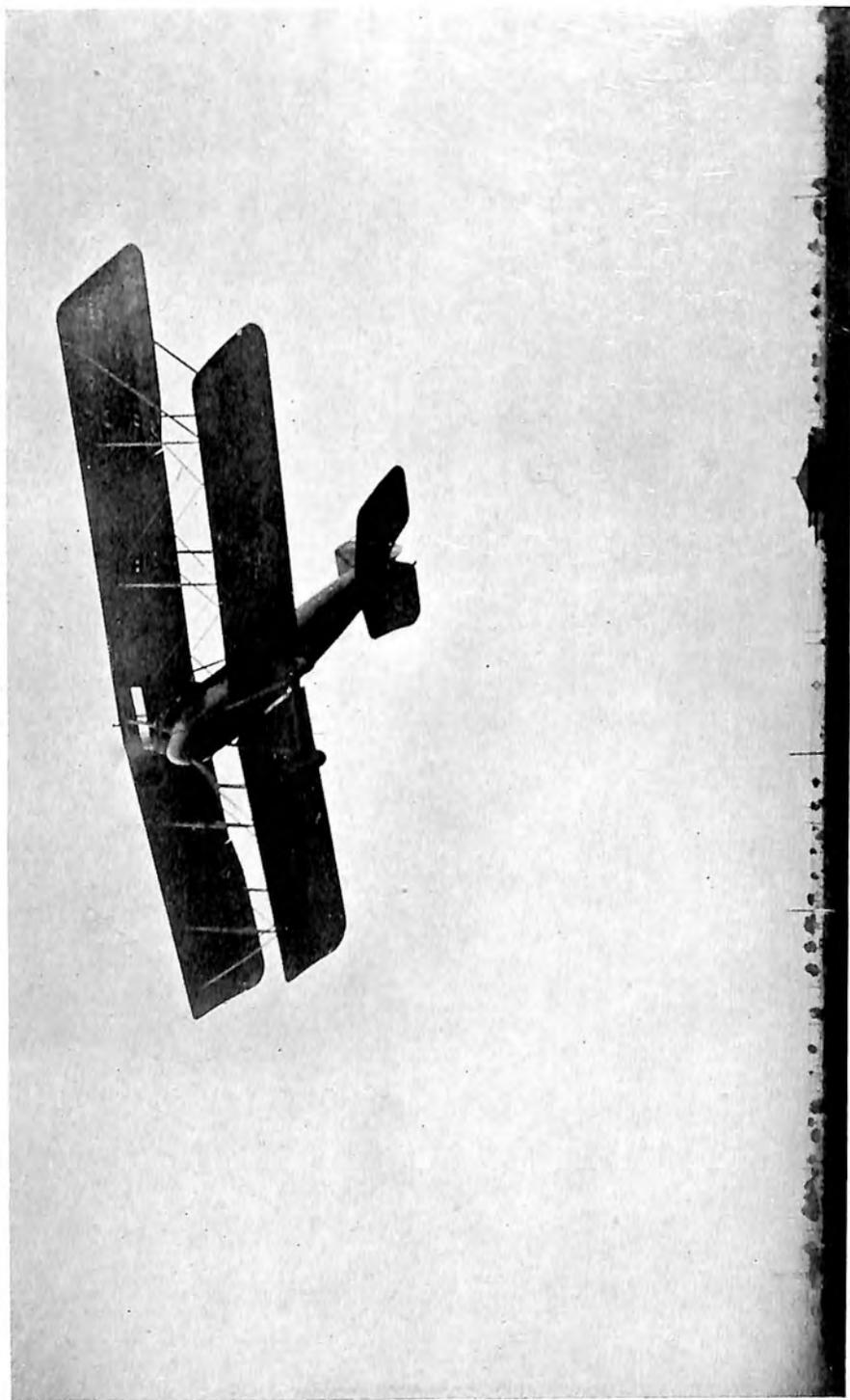
From top to bottom: 1—R. F. HOFFMANN; 2—DH-4 Mail Plane, remodeled by L-W-F Company
3—CAPTAIN JACK FOOTE; 4—GLENN D. MITCHELL; 5—A. S. FLACHBAR; 6—DH-4 remodeled
showing L-W-F Landing Gear and Mail Cock-pit.



The L-W-F Engineering Corp.

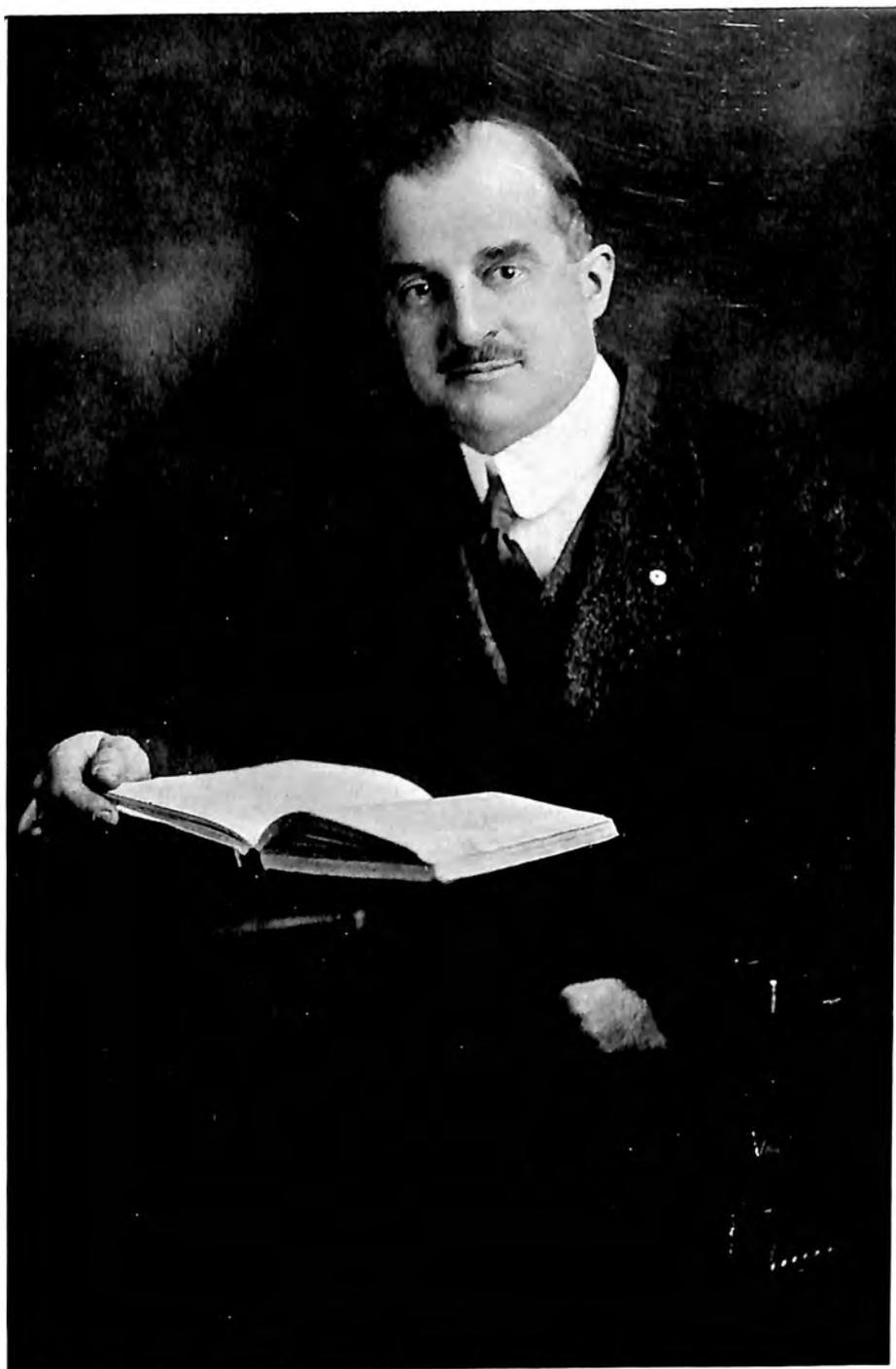


any's Plant at College Point



Model F, the first machine to fly the Liberty 8-Cylinder Motor. (See pp. 171-172)

The Company is fortunate in having as testing pilot a man of varied and remarkably intensive training. Captain J. M. Foote has been with the United States Aviation Service from December, 1916, until January, 1919. He has instructed in the Government service, having charge for a time of all the machines at Rantoul, Illinois, has made trips of over a thousand miles' duration, tested dozens of types of machines and motors, and has studied foreign methods of testing as a representative of the Technical Section of the Government Air Service. In the thoroughness and excellence of his training he is typical of the company with which he works, which seeks to develop an organization as efficient as possible in every detail, in plant, in plant equipment and personnel.



PRESIDENT HARRY BOWERS MINGLE

STANDARD AIRCRAFT CORPORATION

ELIZABETH, N. J.

HARRY BOWERS MINGLE *President*
EDWARD E. PENNEWILL *Vice-President*
MAX J. FINKLESTEIN *Vice-President and Treasurer*
CHARLES HEALY DAY *Vice-President and Consulting Engineer*
MEIJEIRO YASUMOTO *Secretary*

Directors

H. B. MINGLE	F. J. MUHLING
M. YASUMOTO	C. H. DAY
J. W. WALKER	HENRY J. FULLER

JOSEPH A. BOWER

PLANTS—Bayway, Elizabeth, N. J.

STANDARD AERO CORPORATION OF N. Y.

PLAINFIELD, N. J.

HARRY BOWERS MINGLE *President*
WILLIAM D. JUDKINS *Vice-President*
JAMES W. WALKER *Secretary*
DANIEL A. MEENAN *Treasurer*

Directors

H. B. MINGLE	FRANCIS J. MUHLING
WILLIAM D. JUDKINS	JAMES W. WALKER

M. YASUMOTO

PLANT No. 1—North Avenue and Berkman Street, Plainfield, N. J.

PLANT No. 2—North Avenue, Plainfield, N. J.

ASK yourself, "What has been the most dramatic and unprecedented aspect of America's service in the war?" and you will find yourself answering, "Speed." And it will not be military speed which you have in mind (for that has been prominent in many wars) so much as the swiftness of our industrial answer to the German challenge. Nothing about this answer has been so dramatic as the development of great aircraft corporations out of a few buildings, a few human minds, and enthusiasm. And nothing could be better representative of this miracle than the growth of the Standard Aircraft Corporations.

There are two of them—The Standard Aero and the Standard Aircraft. The Aero, the older, began life May 12, 1916. It came from the chrysalis of an aero company, weak and unpromising. It had but two things—liabilities and a vision. The liabilities are now of no

importance. But the story of how the vision of such men as President Harry Bowers Mingle and Chief Engineer Charles H. Day made the Standard all that its founders dreamed of is one of the romances of the recently ended war.

The old company from which the Standard was founded had built two machines. The Standard Corporations have constructed seventeen distinct types of airplanes, some models of which had been made in very large numbers, and had a capacity of hundreds of planes a month when the armistice was signed. Its slogan of "a plane an hour" had been reached and passed.

This within the compass of a brief seventeen months. Within this time the Standard Aero Corporation had increased its plant at Plainfield from a single building to two distinct manufacturing plants with a total floor space of over 225,000 square feet. With the incorporation and creation of the Standard Aircraft Corporation a plant at Elizabeth, New Jersey, was acquired, which at the time of the armistice contained thirty-four distinct and separate buildings, some of enormous size with a floor space of 614,190 square feet.

This organization was called upon to develop and produce planes of its own creation and planning, and that of other American inventors and producers. But of greater significance was the development and production of foreign planes. Despite the necessity of adapting English and Italian planes to American materials and methods of production, and in many important parts and details to a complete change to suit American conditions, the Standard Corporations fulfilled their duties to the entire satisfaction of international requirements, and in record-breaking time.

As an example, there is the development of the English Handley-Page. England was at her limit. There was a scarcity of materials, of labor—of everything. The Standard was called upon to meet the emergency. Within 90 days from the time of receiving the order the first American-built Handley-Page, "The Langley," was built, functioning 100% from the moment it took the air. Not an employee or official of the company had ever worked on, or even seen, this type before. Plans according to American standards had to be drawn. American made engines had to be installed. Various American instruments had to be added. Yet the whole was completed in this brief time, and behind it were the parts for forty machines boxed and ready to ship overseas. This first Handley-Page was christened on Saturday, July 6, 1918, at a ceremony which was the first christening of an airplane in history. Among the invited guests



The Standard-built Caproni

were men and women of national and international fame and importance. Mr. Benedict Crowell, Assistant Secretary of War; General Kenly, Chief of the Aeronautical Division of the United States Army and John D. Ryan, Director of Aircraft Production, represented the Government at the ceremony. Senator Frelinghuysen of New Jersey and Senator Thomas of Colorado, represented the United States Senate. Also present was Mr. Samuel P. Langley, nephew and namesake of the father of American aeronautics, for whom the airplane was named.

Major-General Sir W. S. Brandser, representing the English Air Service, gave unstinted public praise to the achievement of the Standard Corporation. Sir Henry Fowler and Colonel the Master of Semple, of the British Air Service, praised the Standard Handley-Page as the best plane of its kind ever produced. Praise from these men was praise indeed, as they had the intimate knowledge of the difficulties which were overcome in making this work successful.

Italy had produced the Caproni, and American officials decided upon its use by our forces. The Standard Corporation was called upon to produce it. Captain Hugo D'Annunzio, the Italian Government Caproni representative in America, came to the Standard plant with a corps of engineers. The plane, which they were to have brought with them to serve as a model, was not on hand. Therefore, the Standard forces produced an American built Caproni from blue



Standard Model H-3

prints alone. The nomenclature of the original drawings was in the Italian language and the measurements made in the metric system, and these had to be changed to American terms and standards of measurements. Upon strict Government test this plane was accepted as the finest example of its kind ever built. It also received the highest praise of Captain D'Annunzio.

Back of the organization which made these achievements possible there was an impelling force, a power which drove it surely and unitedly. The one asset which the young company had built upon the remnants of the old insolvent institution was men. There are men who plan, but know not how to achieve. There are men who conceive, but know not how to produce. The Standard Corporations had men of vision, men of talent, men who sensed the needs and went about determined to achieve.

First and foremost of these was its President, Harry Bowers Mingle. A business man is usually into the game early in life, but in 1899 the future president of the Standard Corporations was taking his B. S. in Economics from the University of Pennsylvania. He then studied law, and pushed his way to an LL.B. from the New York law school, in 1902. He has been a specialist in Corporation Law ever since. While holding a case book in one hand, however, Mr. Mingle was drawing up with the other the corporation papers for the Depew and Lake Erie, the Western New York and the Rochester and Lake



Upper row: E. E. PENNEWILL, OVERTON M. BOUNDS, MAX J. FINKELSTEIN; Center, CHAS. H. DAY;
Lower row: ALEXANDER MILNE, WM. J. TYNAN.



Model J-R Tractor Biplane Advanced Training Machine

Ontario Water Companies, and found time to act as Director and President of these corporations, who were supplying railroads and manufacturing plants with water along the New York Central. He was later connected as Director with the Cochran Land Company, the Cranford Development Company, West New York Land Company, and is now a Director of the State Trust Company of Plainfield, New Jersey.

Business and law are Mr. Mingle's professions, but his interests have been drawn to everything in life worth knowing. He never forgot his University experience; from 1899 to 1917 he served as Secretary to the University of Pennsylvania Club in New York City. He is Vice-President of this club and was President of the Graduates Club of New York, and Vice-President of the Delta Upsilon Club of the same city. He belongs to the Essex County Country Club and the Orange Lawn Tennis Club—evidences of his New Jersey domiciling. He is a member of the Aero Club of America, the Society of Automotive Engineers, the Japan Society, the Lotos Club, the Hardware Club, the Pennsylvania Society, the Academy of Political Sciences of the City of New York and the American Bar Association. In educational lines Mr. Mingle is a director of his Preparatory School, Williamsport Dickenson Seminary and was a director of his Alumni Society at the University of Pennsylvania.

An American of the old stock, Holland Dutch, far back on his father's side, Mr. Mingle has left few aspects of modern America escape his notice. The diversity of his talents as embraced in his



Standard Model D Twin-motored Hydro-aeroplane

membership in these numerous organizations is particularly noticeable because, not satisfied with merely being a member, he at all times took a prominent part and interest in their management and growth. This same zest and tireless energy he brought to the Standard Corporation when opportunity brought it to his notice and from its very inception he has always been its leader and guide. How well he guided and managed needs no comment, the facts speak for themselves.

The Standard was fortunate in having with it in its inception Charles Healy Day, one of the first designers and flyers of the Tractor type of airplane. Mr. Day is now its Vice-President and Consulting Engineer.

The story of Mr. Day's life reads like a modern tale of adventure, a veritable romance. A New Yorker by birth, with training at the Rensselaer Polytechnic Institute, he knocked about California and Alaska, draftsman, and engineer, instructor in mining engineering, partner in the Auto Repair Company of Brown and Day before he had attained his majority.

Selling his interest in the firm of Brown and Day in 1905, the youngster of twenty-one established a successful auto stage line in Rhyolite, Nevada. He left this venture when Nevada was too old a story for him, and in 1909, while operating a motorcycle agency at Long Beach, California, he built a complete airplane, including the motor, working on his hobby at night while selling motorcycles by day.



Standard Model J—a 1916 product

He had begun building airplanes, and he was never to stop. There were the usual pioneer experiences; "I worked all week on the machine and wrecked it Sundays." And after a fall from 100 feet at Dominquez Ranch, Day limped away shaking his fist at the broken machine. He never wanted to see it again and never did. But it was of no use to throw away the airplane, for he was soon designing another for Glenn L. Martin at Santa Anna, Cal. Day wanted to build a tractor, however, and Martin did not; the two parted and the tractor was built in 1912.

The baby Day Tractor, as it was called, went to Chicago with the inventor, who was now representing the Hall-Scott Motor Car Company, and it was flown by De Lloyd Thompson in sensational exhibitions. After starting and selling an airplane factory and acting as Chief Engineer for Glenn L. Martin until 1914, Day finally built a special looping machine for Thompson, and the two startled many a spectator in various parts of the United States with their looping exhibits. Any flying cadet can loop to-day, but in 1914 looping was an adventure as dangerous as battle.

Mr. Day was called from "aeronautical acrobatics" in the West to design real airplanes in the East and thus found himself with the Standard Aero Corporation in 1916.

The skill and daring as an engineer and flyer which Mr. Day brought to the new company were utilized to the highest degree, and to-day aviation authorities concede Mr. Day's eminence as an aeronautical engineer and the Day Tractor type is recognized as highly noteworthy in the realm of airplane design.

In the early days of the Company Mr. Day with an assistant or



Standard Model JH, a Tractor Hydro-aeroplane

two embraced the entire engineering staff. He not only had to conceive, but usually had to draw the idea he had in mind, but gradually the engineering force had to be increased, and fortunate was Mr. Day and the Company in obtaining as assistants the services of engineers of unusual competence and ability. Among these are William J. Waterhouse, Thomas H. Huff, John D. VanVleit and George Edward Barnhardt.

The multiplicity of designs, the great increase in the Company's activities afforded an opportunity to create departments in the Engineering force and Mr. Day placed these assistants at the head of these divisions.

William D. Judkins, Vice-President; J. W. Walker, Secretary, and Daniel L. Meenan, Jr., Treasurer, constituted the experimental organization when they organized the Standard Aero Corporation in May, 1916, when the firm began to look for business. The airplane industry was still regarded as a freak—an interesting plaything for the rich, perhaps; even as an adventuresome proposition for the daring sportsmen, who had little respect for his life insurance policy and a great deal for the possible plaudits of the populace. But it was not considered practical.

The little plant at Plainfield, New Jersey, now grown larger and only one of three which are under Standard supervision, gave no promise of dynamic growth. It was up to the Company to hunt a



Model H-4-H—a Hydro-aeroplane for advanced training

future, and even the hunting seemed poor, but Mr. Mingle and his associates were not only determined, but were very good hunters. Although the Government was not contemplating war with Germany, the development of aviation on European battlefields had awakened it to its need for improved equipment. Our aviation section was amazingly small and out of date. Our government was not interested in aircraft. The new Company made a proposal to build Government machines, and, finally, a contract for twelve airplanes was awarded it.

It was a small opening, but large enough for the Standard. The order was accepted, completed, and the planes delivered according to schedule; this speaks volumes. The completion of this order entailed the creation of the homogeneous force which had to be trained and developed into the production of to them an entirely new product which called for exceptional skill and ability. This was accomplished. Both men and women were trained to do their respective work and did it successfully and on time. The great secret of this work lies in Mr. Mingle's humane expression, "No man or woman in the Standard Corporation works for me but with me," and work with him every one did.

On October 30, 1916, a second order was accepted, this time for eighteen primary training, twin engined, hydro-airplanes. The model was J, the motor a ninety horse power Hall-Scott A-7 and



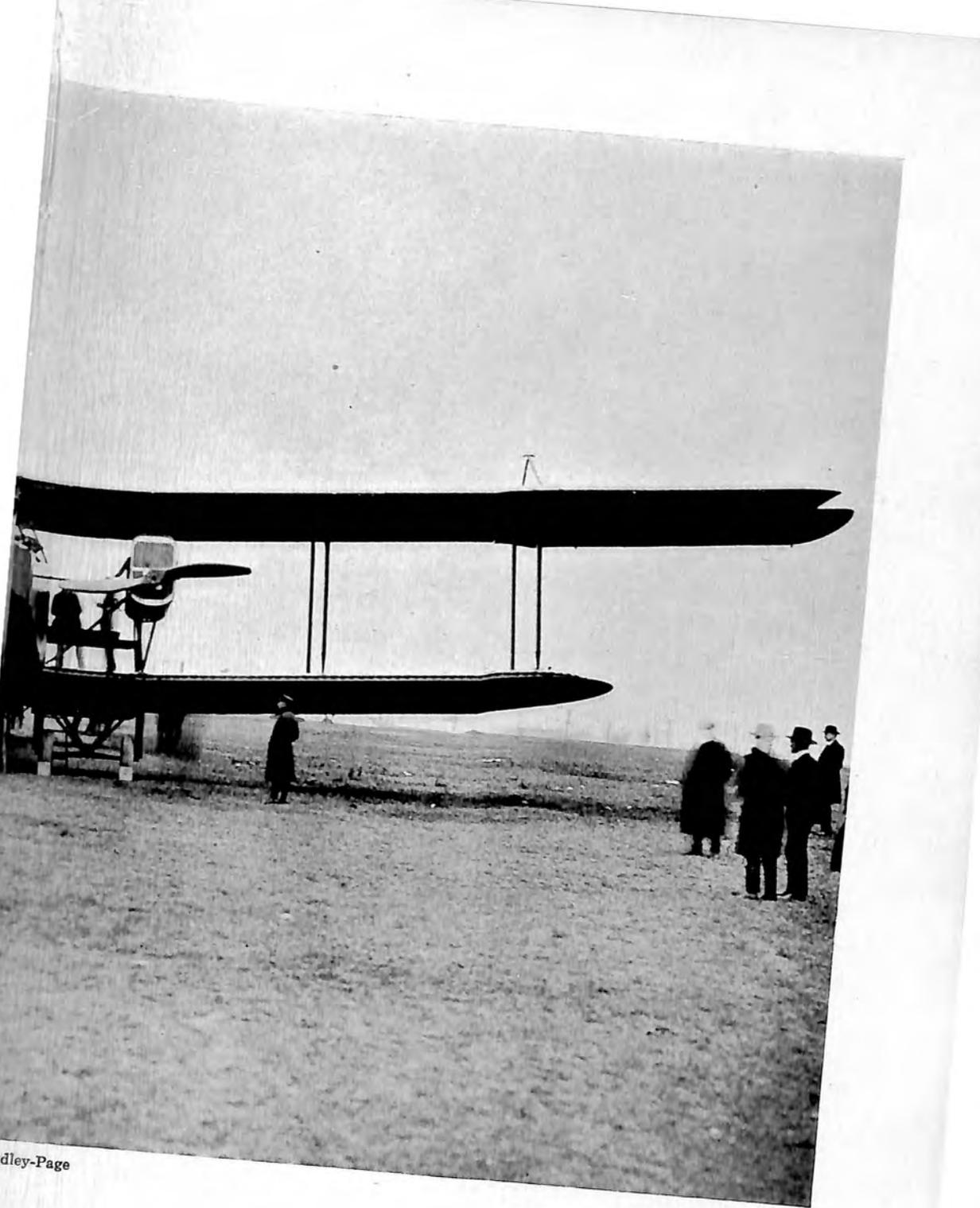
Model E-1—a defense advance training Tractor Aeroplane, single-seater with a 100 H.P. 9-Cylinder Rotary Gnome Engine

the price \$8,550 per machine. On January 24, 1917, the first machine left the ground to make an official speed record, and although it was thought advisable to delay official endorsement until an A-7-A Hall-Scott motor had been tried, on April 18, 1917, the type was accepted by the United States Government and an order was given for 100 J-1 machines. The working force was immediately increased from 75 to 175 workers, and in time this reached the grand total of over 6,500 operators working directly in the Standard plants in both Plainfield and Elizabeth, and of many more thousands in various sub-contractor's plants throughout all parts of the United States.

This force in time produced the following types of machines:

- | | |
|------------------------------|--------------------|
| (1) Training Plane. | (10) JR. |
| (2) Advanced training plane. | (11) D Hydroplane. |
| (3) Hydroplane. | (12) HS-2-L. |
| (4) JL. | (13) E-1. |
| (5) J-1-B. | (14) E-4. |
| (6) JR-1-B. | (15) Handley-Page. |
| (7) D. H. | (16) Caproni. |
| (8) H-4-H. | (17) E-2. |
| (9) JH. | |







Model JR-1-B, used for the United States Post Office Aerial Mail Service

“Every type of plane flown has been produced,” a record achieved by no other aeronautical organization. Most airplane plants have limited their activities to one special type, and perhaps one or two firms have undertaken two types. The Standard successfully undertook and completed every type of plane that was brought to its notice and many on its own account.

Early in 1917 an aeronautical exposition was held at Grand Central Palace, New York City. The Standard Aero Corporation entered an exhibit and there received a recognition which added to its growing prestige. The United States was on the eve of war, and Mr. Mingle saw that the first step toward efficient service on the part of aircraft manufacturers must be a getting together. He became instrumental in organizing the Aircraft Manufacturer's Association, and was chosen its first president. He held this office until May, 1917, when the rush of increasing business impelled him to resign that office. He now continues as Director and Treasurer of the Manufacturers Aircraft Association, which was later formed from the nucleus of aircraft manufacturers brought together in the earlier organization.

The Standard Corporation had not hesitated to increase its capacity after the declaration of war on April 6, 1917. It had constantly made representations to the government as to its willingness and ability to do more than manufacture training planes. The Standard Aircraft Corporation had been organized, the old Stevenson Car



Model E-4. This is identical with JR-1-B, except for overhang. It mounts a 150 H. P. Hispano-Suiza Engine

Plant at Elizabeth, New Jersey, acquired and remodeled, and the corporation, with its plans maturing for a larger capacity, waited upon the government.

It waited long. Washington had not yet decided upon its policy. And when it did decide, in October, 1917, it placed no orders for fighting airplanes with the Standard, although it included the company as one of its prospective producers. In January, 1918, however, orders for fighting aircraft did come, and since that time the corporation has manufactured successfully DeHaviland-4's, the HS-1-L, HS-2-L, Flying Boats, a special Postal Plane, the twin-engined Handley-Page bomber, and the three-engined Caproni. No firm can boast a greater variety of production.

And though the Standard was equipped to build anything and its variety of product was so diverse, and though all this was crammed into less than a year of war production, its quality of workmanship been superior, and a "high standard of excellence" has been its watchword.

The "Standard built Postal Plane," used in the United States Air Mail Service, has received official recognition from the Post-office Department as having a record of ninety-nine per cent plus efficiency since it was placed in operation.

Ensign W. J. Leisenring, U. S. N. F. C. was official pilot in the test flight of the HS-2-L, and to quote his own statement, "I made the trip to Cape May from the Statue of Liberty in one hour and fifty minutes without any trouble whatever despite the newness of the machine and (to me) new flying airway, and in spite of contrary head winds."

Secretary of War Baker, on his return from his trip to France,



The Standard HS-2-L Flying Boat, with 12-Cylinder 320 H.P. Motor

where he made a special investigation of the needs and requirements of the American air service, visited the Standard plant on June 6th, 1918, and highly praised the workers. Governor Edge of the State of New Jersey also officially inspected the plant and addressed the organization as "Men of the second line defense."

In all its activities and in whatever specifications there were to be followed, the Company has put its utmost energy into an accurate and intelligent workmanship, strict and careful supervision, and scrupulous honesty throughout. It has increased its facilities to give each job all that it required in every respect. This has in part accounted for the size to which it has grown and the success it has attained.

The Standard Aero Corporation, the parent Company, maintained two plants at Plainfield, New Jersey and one at Elizabeth, New Jersey, where it carried on experimental work and the production of special machines. The Standard Aircraft Corporation, at its enormous plant at Elizabeth, is the real producer for the corporations, and its twenty-four separate buildings, its flying field, and its 608,785 square feet of floor space tell their own story. When President Mingle declared recently, "We are ready to make anything," he was not making a boast, but simply giving an idea of the company's equipment.

"One of the reasons why we have been able to do so many things and to do them efficiently," said one of the officials, "is because we



Standard Aircraft Buildings at Elizabeth, New Jersey. From top down: 1—Building No. 1; 2—Main Offices; 3—Handley-Page Building; 4—Building No. 10



The Standard DeHaviland

have educated our employees to understand what their work means, and have in every way co-operated with them to make their labor pleasant as well as useful. We gradually taught every man and woman in our employ to understand the airplane. Every one knew what was the function of the part he was making. He knew that neglect on his part might mean loss to the government, the defeat of an American flyer, the death, even, of a brother, husband, or son. We had exceptionally careful workers, and little wasted work. We detected only two cases of sabotage, and had found and were watching the malefactors before they had done any mentionable damage." This record, in the instance of a factory which employed as high as 4,500 workers, is an interesting contribution to the history of the relations between employer and employed. To get efficiency in work new to the workers, and demanding, in the words of the Standard's president, "the strength of a battleship, the delicacy of a watch's mechanism, and the tuning up of a fine piano," is an achievement deserving record.

All this points to an organization of remarkable efficiency and is evidence of the fact that unusual talent and acumen had been employed in the selection of Department Heads and supervising officials.

The genius of Mr. Mingle was everywhere and he was closely aided by Mr. Max J. Finkelstein, Vice-President, Treasurer and

Counsel for the corporation. Here, too, was the highest type of skill, integrity and activity displayed. As able assistants, Mr. Finkelstein had Assistant Treasurer Charles G. Straat, Comptroller R. A. Kettley, with a corps of accountants, and clerical staff. The financial and clerical organization of the company grew from a mere handful to a staff of many hundreds.

The Engineering Department under the supervision of Mr. Day rapidly grew to a large and complete technical organization, and great credit is due to Mr. Day's chief assistants. William J. Waterhouse, a graduate of the University of Notre Dame, had followed aviation in the United States from its beginning. Before going to college he had worked with Curtiss in 1909 and 1911. He knew Dr. Zahn, who had worked under the first pioneer, Langley, and was later chief consulting engineer for the U. S. Navy. It was as the youngest practical aeronautical engineer in the country that Mr. Waterhouse flew in 1911, and opened an opportunity to join the Curtiss Company at Hammondsport in 1914, as research aeronautical engineer. The U. S. Signal Corps persuaded him to leave the Curtiss Company, and for two years, from 1916 to 1918, he served the Government. He had met Mr. Day in 1911 at Cicero, Illinois, and had never lost touch with the latter's work. When he was sent by the Signal Corps to the Standard's Elizabeth plant it was a natural step from governmental to corporation work with a man whom he had known and watched for years.

Another engineer with early aeronautical experience is Thomas H. Huff, who, it seems, was only later than Mr. Waterhouse in taking up theoretical flying because he was born seven years later. But though only twenty-five when he entered the Standard employ, Mr. Huff had instructed in aeronautics at his alma mater, the Massachusetts Institute of Technology, where he worked with Commander Hunsacker in experimental work and published a number of articles in his own name, or in connection with Commander Hunsacker and Lieutenant Alexander Klemin. He had then served for a year as Aeronautical Engineer for the Sturtevant Airplane Company.

Closely related to the engineering comes the inspection of everything that enters into the manufacture of airplanes. Every little detail, every minute part, from the raw material to the completed plane, must be inspected and closely guarded from inception to completion. There are no "ifs," "buts," or "perhaps's" in the airplane industry. The limit of tolerance is set at the highest point humanly possible, for human life depends upon the perfection of the completed

machine. Such rigid inspection calls for supervision of the highest type, and the Standard in this respect was fortunate in having Mr. William J. Tynan as Chief Inspector. For this work Mr. Tynan was well fitted by a thorough training, theoretical and practical, in gas engines, and airplane motors particularly. Although having had four years of University work such training as his two years of experimental and research work with Hiram Percy Maxim stands out as of inestimably greater value than his academic preparation. Two years in the engineering department of the Western Union fitted him, with his gas engine experience, to work for and help direct the policy of the Electric Vehicle Co. from 1909 to 1912. The Columbia Motor Company, the United States Motor Company and the Crane Simplex Company are on the list of his affiliations. He worked with M. M. Crane on experimental aero engine work, assisting to get the American Hispano-Suiza ready for production. All this Mr. Tynan did in less than forty years, for he saw New Jersey and the world for the first time in 1879.

There are those who plan the mechanical work of an airplane factory, and there are those who plan its business future, but neither can work successfully without the men who watch and correct the process of construction, and here Edward E. Pennewill, who is Vice-President of the Standard Aircraft Corporation, had ample opportunity to prove his early training. Born in Philadelphia in 1882, he graduated from the University of Pennsylvania in 1905, and has had a business experience of many years with the Abraham Cox Stove Company and the Cramps Shipbuilding Company of Philadelphia and with other men of wide experience and great ability was called upon in the rapidly expanding work, to exercise his talents in the production of aircraft.

Louis G. Randall, Superintendent of the Aero plant at Plainfield, New Jersey, who was born in the national capitol in 1875, worked on a survey of the Nicaragua Canal, later with the Washington, Baltimore and Annapolis Railroad, and as Assistant Engineer for the District of Columbia.

Alexander Milne, General Superintendent of the Standard Aircraft Corporation, was born in Brooklyn in 1876, and is an expert on general shop practice and highly qualified in construction work through a long experience in building and general contracting. He is a graduate of Pratt Institute.

Vice-President William D. Judkins of the Standard Aero, "a grand young man" of sixty-two, is the Nestor of the Corporations. In the



Top row: BENJAMIN L. WILLIAMS, JULIUS M. MEIRICK, WILLIAM P. JUDKINS; Center: THOMAS H. HUFF and WILLIAM J. WATERHOUSE; Lower row: DANIEL A. MEENAN and RAYMOND C. TAYLOR



The Bank outside the Standard Aircraft Corporation yards, the Executives' Restaurant, and the Carpenter Shop at Elizabeth, N. J.

early days it fell to his lot to obtain the orders for the company. He accomplished this with a remarkable skill, and was instrumental in building up the good will for the growing organization.

Daniel A. Meenan, although only twenty-five years of age, came to the Standard from the Sloane Company, which he had served as Secretary and Treasurer since his graduation from Columbia in 1914. He resigned as Treasurer of the Standard Aero Corporation in the spring of 1918.

Raymond C. Taylor first joined the company on August 8, 1917, and was successively in charge of field work, transportation and shipping, Assistant to the General Manager, General Manager, Assistant Secretary and Assistant Treasurer of the Aero Corporation, and is now Assistant to the president. His indefatigable energy and exceptional ability have won him steady promotion and deserving praise and recognition from all his associates.

Benjamin L. Williams, Special Assistant to the president, came to the Standard from the Manufacturers Aircraft Association, and his knowledge of aeronautical affairs was put to the best use in the upbuilding and growth of the Standard Corporation. His capacity for special detail work made him a valuable assistant to Mr. Mingle.

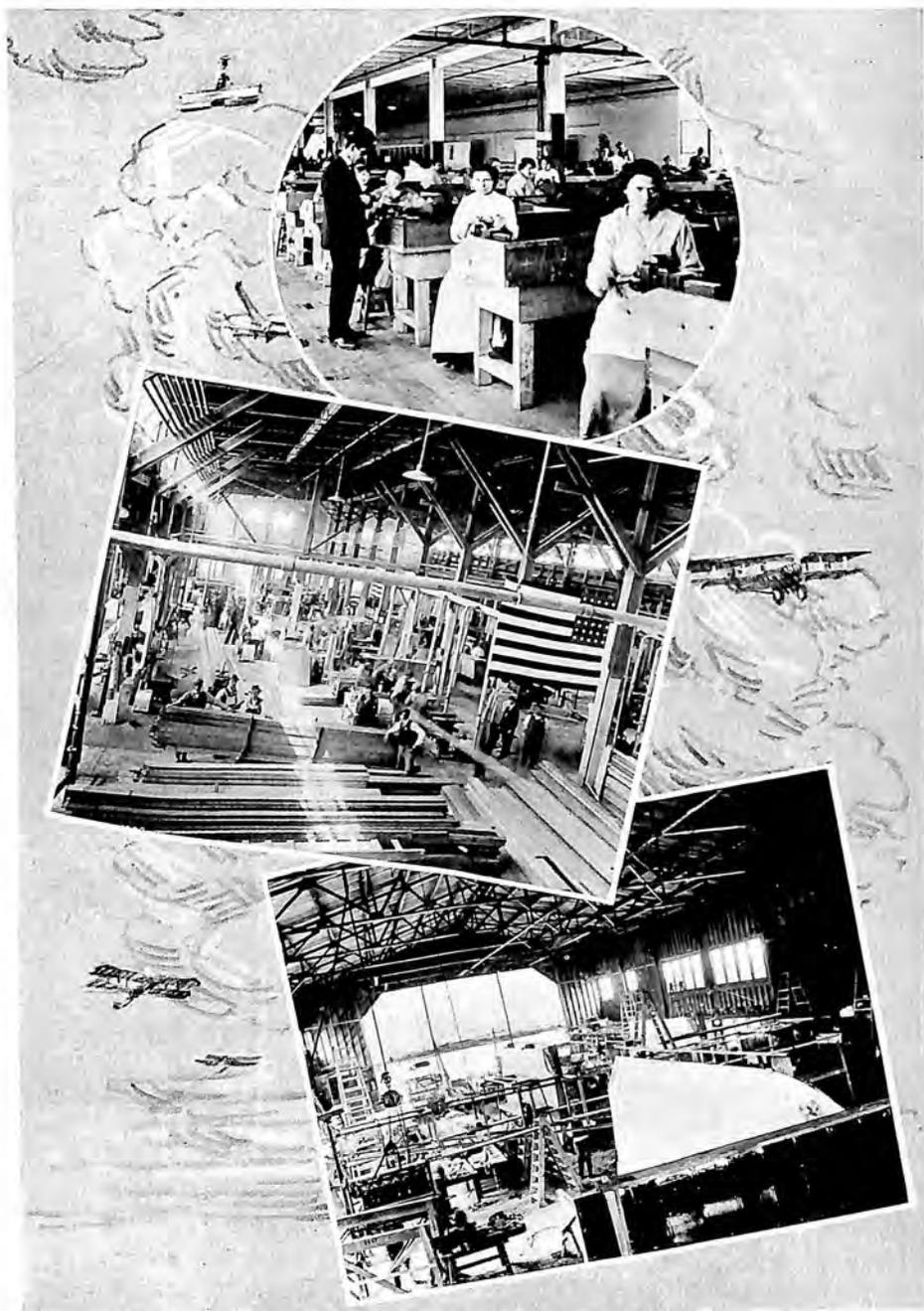
Julius M. Meirick, Superintendent of Publicity, joined the Standard Corporation on February 14, 1918. He has undoubtedly done much to encourage and stimulate interest in aircraft production and has earned a conspicuous place in the company's history.

As editor and publisher of *The Tractor*, he gained for that publication a reputation far beyond the bounds of the Standard plants. Although termed a publication for and by the employees of the Standard Corporation, it gained such prestige that every camp and cantonment wherever American warriors foregathered asked for and received many hundred copies of each month's issue.

Mr. Meirick had full charge of the various Liberty Loan and other war drives and not only won the 100% banner in each case, but gained the prestige for the corporation of having one of the highest averages of any industrial plant in the United States.

In the field of publicity, the many thousand columns of newspaper and magazine space given to the Standard Corporations are alike evidence of Mr. Meirick's ability and the Standard's conspicuous activity. In the field of Advertising the original and high-grade illustrations and language employed received the unusual compliment of serving as a standard for other manufacturers.

Under Mr. Meirick's supervision the government at the Standard



Girls' Filing Department, Woodworking Department, and Handley-Page Temporary Building, showing machine in course of construction—all at the Standard Aircraft Plant at Elizabeth, New Jersey

plant prepared a motion picture story of the building of airplanes from inception to completion. The Langley book, presented Mr. Mingle by the executives of the company as a souvenir of the launching and christening of the Langley on July 6th, 1918, was produced in its entirety by Mr. Meirick, and is a volume of unusual beauty and artistic production. Its pages carry the autographs of many of the most prominent personages in America and England.

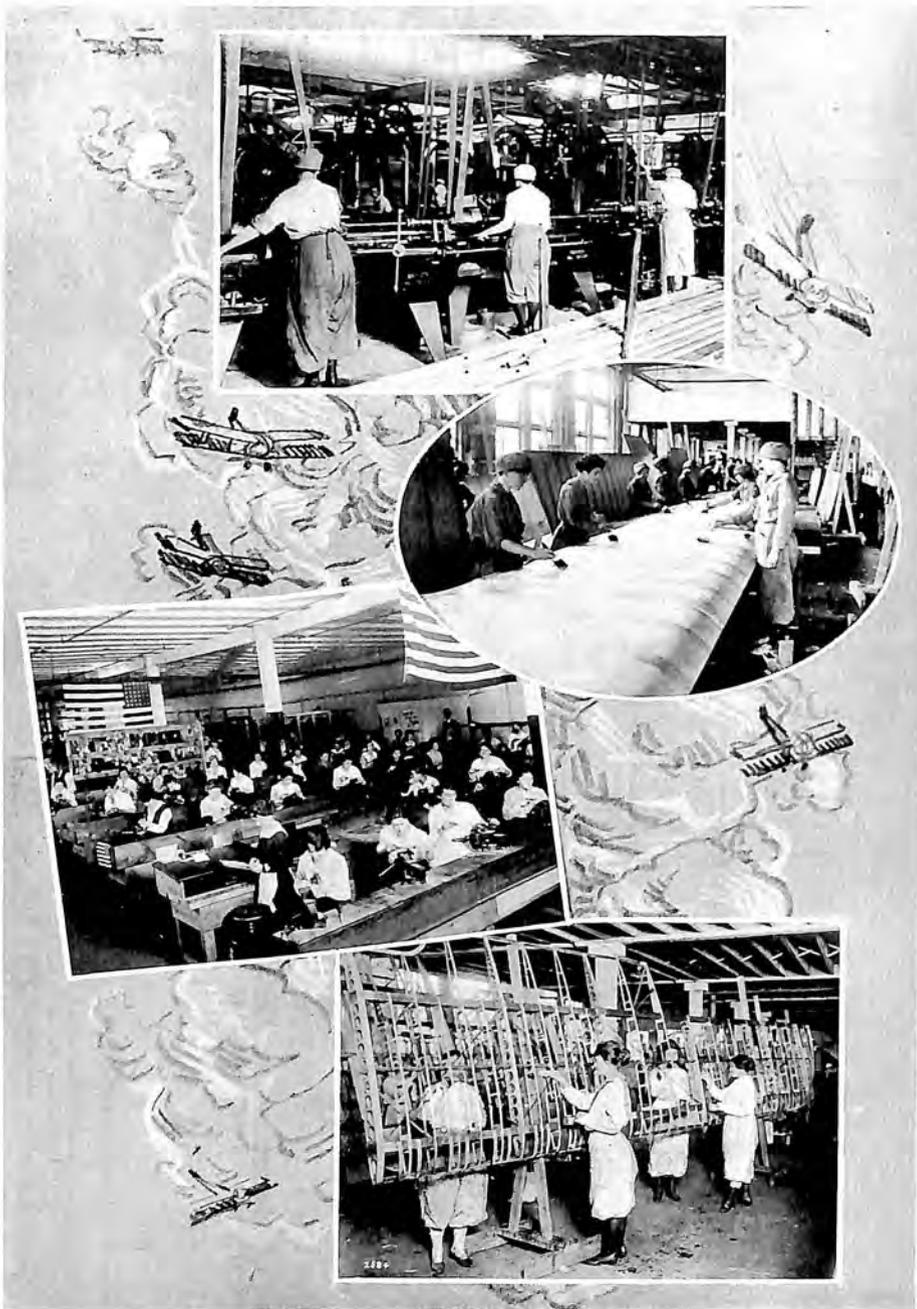
From the very beginning Mitsui Company, Limited, of Japan, has confidently supported the Standard Aircraft Corporation through the uncertain period of experimentation, and by reason of its high motives as expressed through its representatives, Shunzo Takaki, Konosuke Seko and Meijeiro Yasumoto, the wonderful progress of Standard has been made possible.

Here ends the record of the remarkable two-year-old corporation which has grown with the air industry to national consequence. But before we pass from a consideration of its achievement, we must note the present and its promise as we have examined the past.

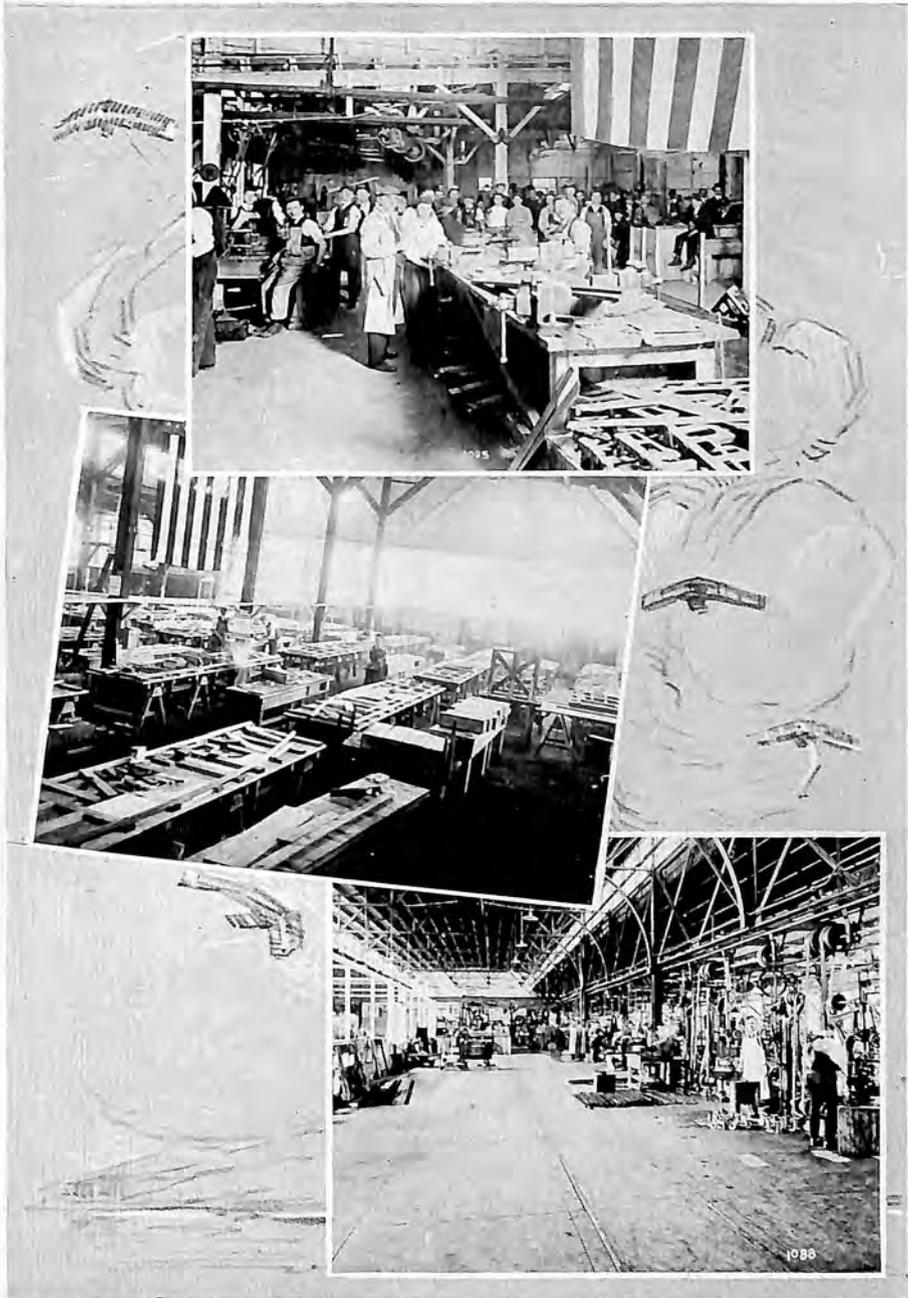
What is the present condition of the Standard and what is its outlook? Financially it is sound. Its last rendered account shows total assets of \$12,365,311.00. Its plants are well-equipped for all kinds of aeronautical experimenting and building. Its executive force is one of wide experience and exceptional talent. The Standard looks forward with a confidence that aeronautical work is in a process of growth to something even bigger than the war has produced. It has the capacity to adapt itself to this growth. It will play its part both in the fulfillment of government orders and in the commercial development of aeronautics in which federal and private initiative will doubtless meet as fellow workers in maintaining the supremacy of the air.



MEJEIRO YASUMOTO



Views in the Standard Aircraft Corporation Factory at Elizabeth, New Jersey



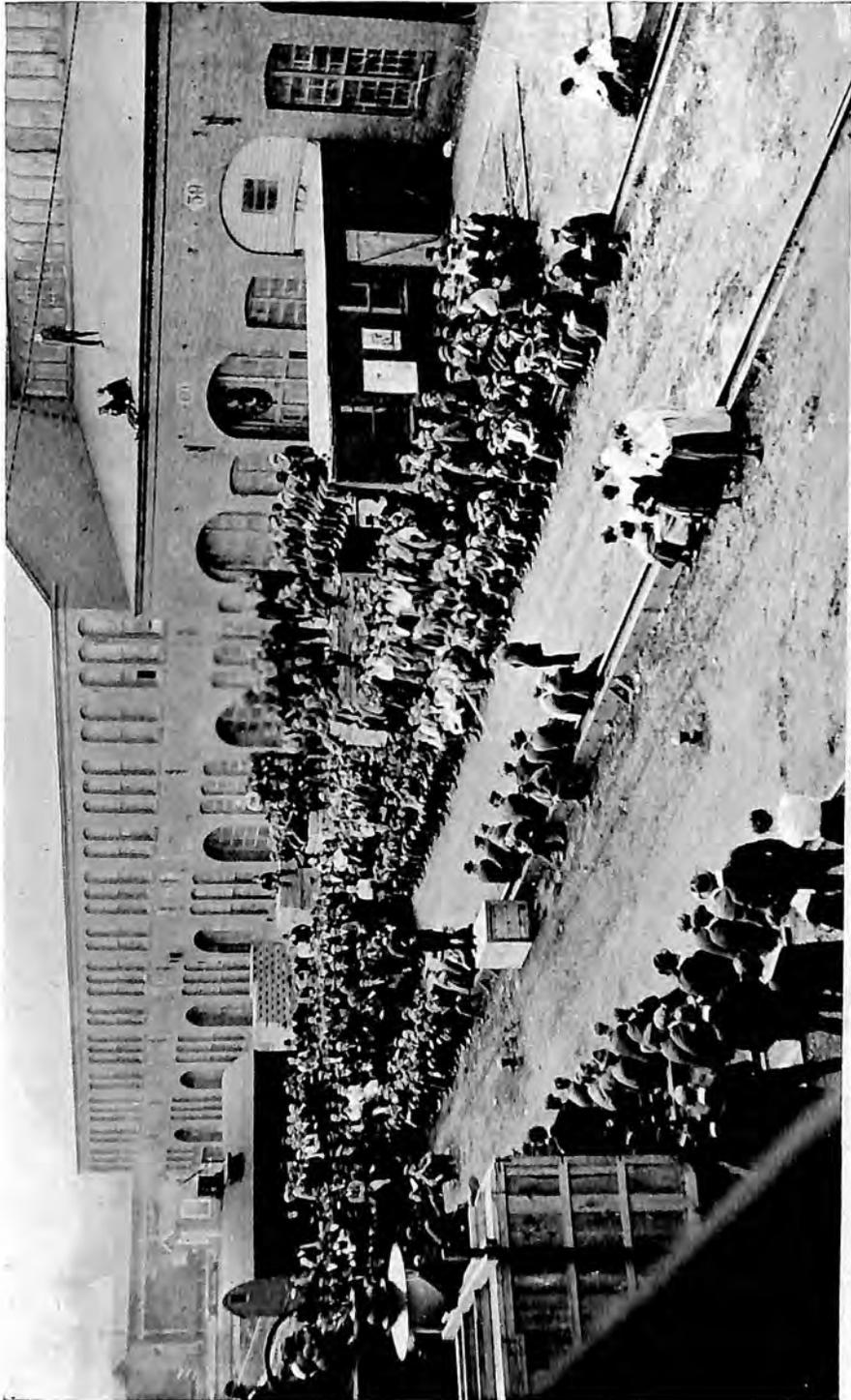
The Welding Department, the Wing Assembly Building, and a general view of the Metal Division at the Elizabeth, N. J., Standard Plant



Aeroplane View of the Standard Aircraft Co



poration Buildings at Elizabeth, New Jersey



A Patriotic Meeting of Springfield Employees



General view of the Springfield Office Building, with Machine Shop, Dope Room, and Wood Mill on right rear

THE SPRINGFIELD AIRCRAFT CORPORATION

J. G. WHITE	<i>President</i>
S. M. CURWEN	<i>Vice-President</i>
W. M. ROSE	<i>Vice-President</i>
R. B. MARCHANT	<i>Treasurer</i>
E. E. BEVERIDGE	<i>Comptroller</i>
A. H. PEASE	<i>Secretary and Assistant Treasurer</i>
E. ROLLAND	<i>Chief Engineer</i>

IT was not until the Government's policy with regard to war aviation had become sufficiently definite to take the form of contracts that the Springfield Aircraft Corporation was organized. On September 27, 1917, Mr. J. G. White of the J. G. White Company, Inc., of New York City, with Messrs. S. M. Curwen, Henry Pearson, W. M. Rose, R. B. Marchant, H. C. Esling, F. W. Brill and W. H. McClintock, formed the corporation and began the manufacture of airplanes. The JN-4-D, JN-4-D2, and VE-7 types were all eventually put into production by the company.

The company leased the factory of the Wason Manufacturing Company, railway car builders, adapting it to aeronautical manufacturing uses. The buildings are of brick and composite construction, and cover about 200,000 square feet of floor space. They have been equipped for the manufacture of all wood parts, sheet metal



General View of Plant—Final Assembly on right; Mill, Dope Room, Tool Room, Experimental Room and Tool Shop

and tube work, and for the machining of all drop forgings and castings.

The company's officers were J. G. White, President; S. M. Curwen, Vice-President; W. M. Rose, Vice-President; R. B. Marchant, Treasurer; E. E. Beveridge, Comptroller, and A. H. Pease, Secretary and Assistant Treasurer, and E. Rolland, Chief Engineer. In addition to these were the following executive officers: H. J. Webster, Superintendent of Final Assembly and Test Pilot; F. DeCormier, Superintendent of the Metal Shop; F. C. Coxson, Superintendent of



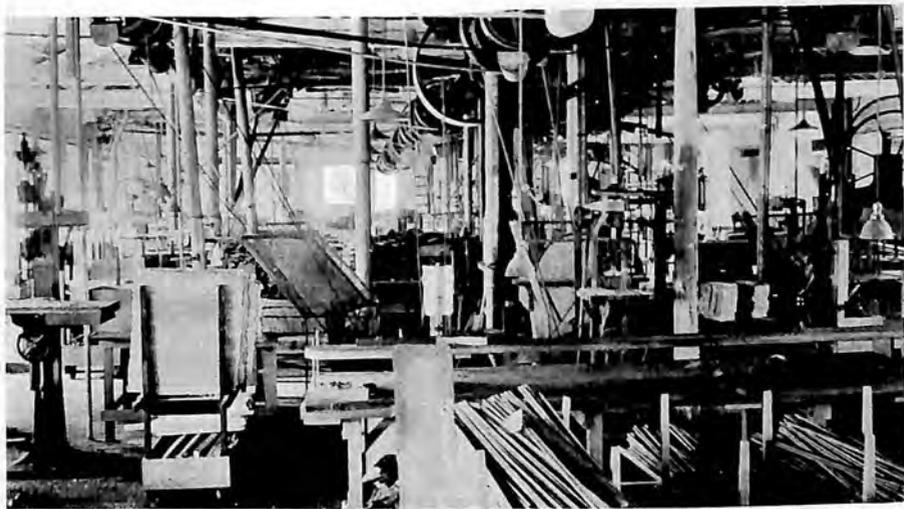
Motor Test on the first completed machine



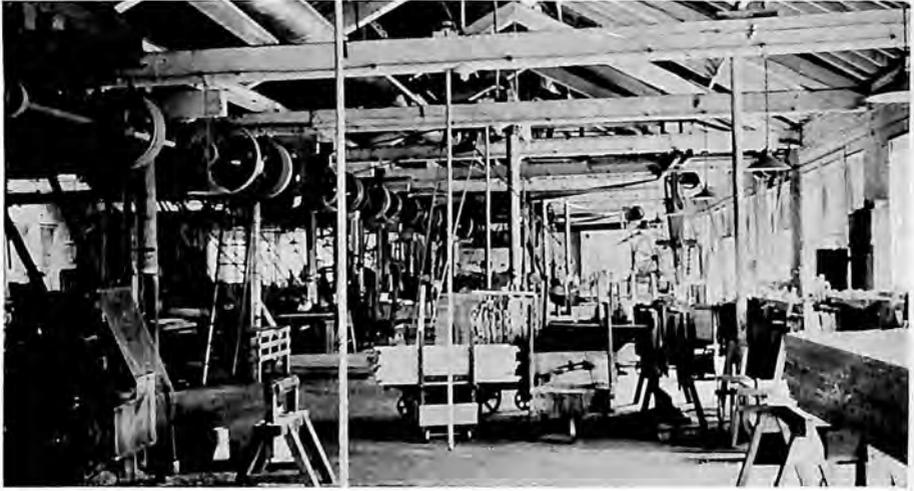
Springfield Corporation Offices, with the first completed JN-4-D in the foreground

the Woodworking Department; Paul Francis, Chief Inspector and Testing Engineer, and K. D. Owen, Production Manager.

The founders of the company were men of business experience of an extended nature. Mr. J. G. White, whose work has been with the corporation bearing his name, has been prominent in engineering and financial circles. Mr. Curwen is president of the J. G. Brill Company of Philadelphia, of which Mr. Esling and Mr. F. W. Brill are likewise officers. Mr. Pearson has been with the Wason Manufacturing Company.

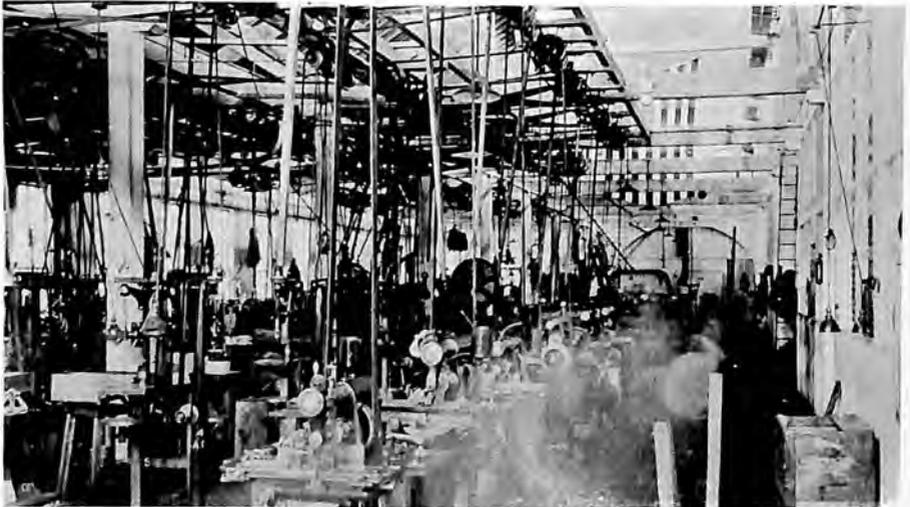


Small Wood Parts Department

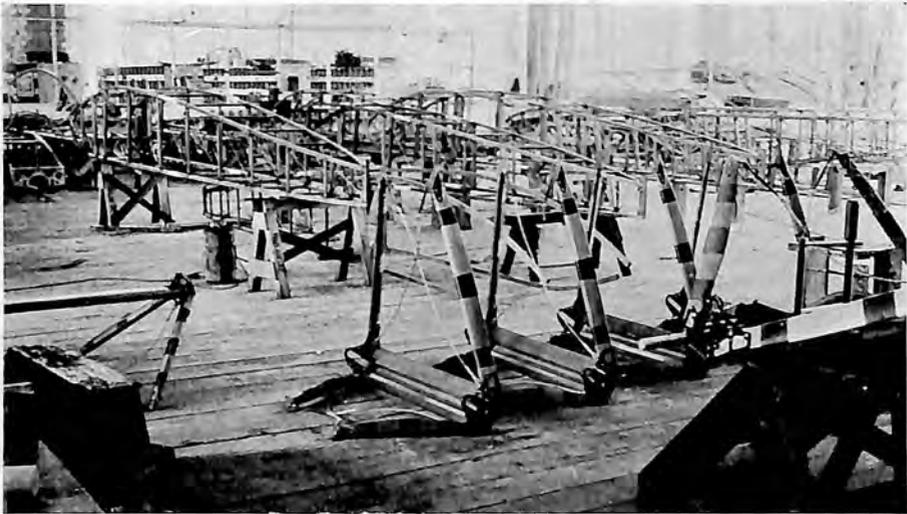


The Woodworking Department

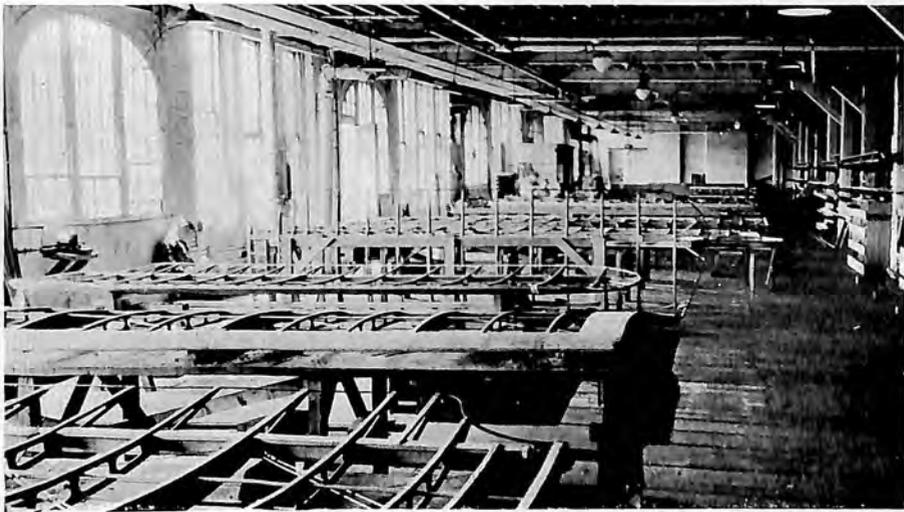
During the war the plant reached a capacity of from five to eight machines per day—all of the primary or advanced training type. The working force grew to a total of approximately 1050. Contracts from the government are now practically completed, and the immediate purpose for which the company was formed—the speeding up of the aircraft program for the war—has been fully realized.



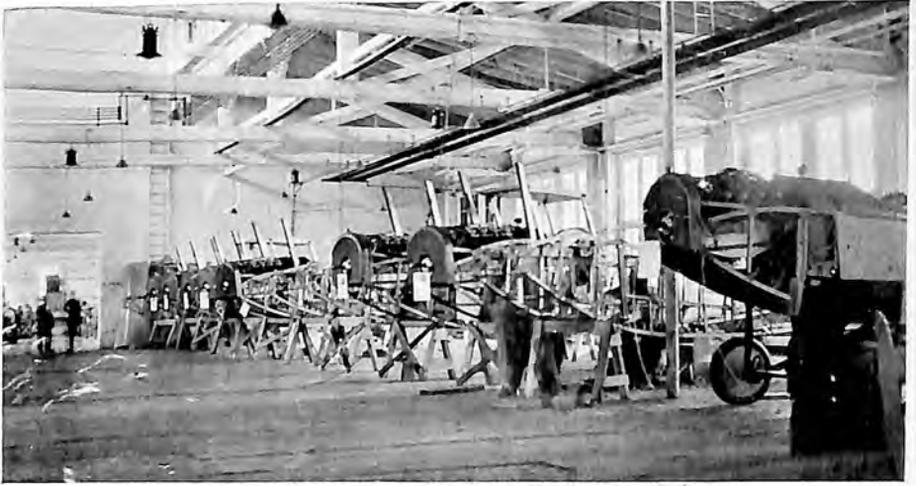
The Machine Shop



Fuselage Skeleton Assembly Department



The Wing Assembly Department



Fuselages ready for covering in the Springfield factory



Crated Planes in front of the Final Assembly Building ready for shipment

THE ST. LOUIS AIRCRAFT CORPORATION

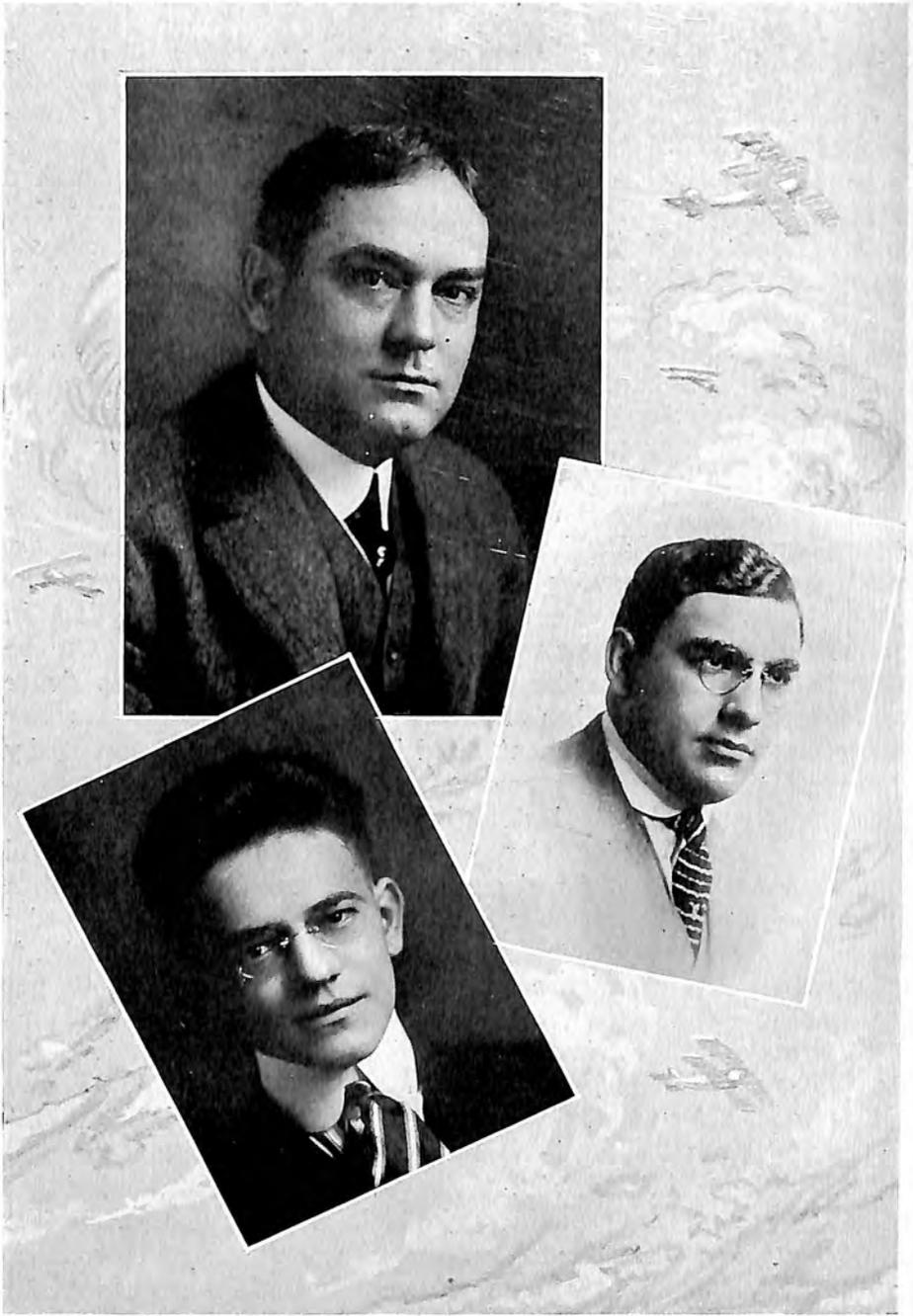
IN the fall of 1917 the Government consulted with certain manufacturers in St. Louis as to the possibility of forming a company to expedite the manufacture of airplanes. As a result of official suggestion, and in answer to the emergency which the war had created, the St. Louis Aircraft Corporation was established.

The men with whom the government had consulted were Mr. A. J. Siegel, President of the Huttig Sash and Door Company of St. Louis, and Mr. Edwin B. Meissner, Vice-President of the St. Louis Car Company. These two firms offered exceptional facilities for the production of aircraft. For instance, the Huttig Sash and Door Company of St. Louis represented an experience with the handling of fir, spruce and pine which was invaluable in the manufacture of flying craft, where spruce is the chief wood used, and the ability to use it properly counts for everything. The struts, ribs, longerons, and wing spars which form the framework of every aeroplane, and the propellers which deliver engine power in terms of speed, represented little in the way of essentially new work to the Huttig employees. On the other hand the St. Louis Car Company had facilities and experience for making a large number of metal fittings which supplement or strengthen the wooden elements, and its shop buildings were easily transformed into assembly rooms for the setting up of the completed models and for the installation of their motors.

The St. Louis Aircraft Corporation was accordingly not called upon to erect buildings for airplane manufacture, and the problem of training unskilled workmen for aeronautical construction hardly existed for it, as the employees of the two companies from which it grew represented experience almost identical with that to be got from actually working on aeroplanes. The corporation could proceed with work almost immediately. Early in 1918 it received the first government order, and some of the JN-4-D training planes which it called for were being turned out for shipment in May.

The emergency corporation began work under its present officers—A. J. Siegel, President; E. B. Meissner, Vice-President, and Ralph Siegel, Secretary. Its growth was immediate and constant. Before the signing of the armistice the company was employing 900 workers. Its first government contract was completed. It was turning out machines at the rate of thirty a week. A second order had been received, which the cessation of hostilities caused to be cancelled.

The history of the company is a history of the application of



A. J. SIEGEL, E. B. MEISSNER, and RALPH SIEGEL

experience in kindred fields to the industrial branch of aeronautics. The larger part of an aeroplane is wood or metal. The Huttig Company was able to apply experience in the handling of wood for structural purposes. Its processes resulted in a remarkable quality and durability of work. Similar results were achieved by the working force transferred from the St. Louis Car Company to handle the production and fitting of metal parts, and the careful assembly of delicately adjusted elements into an effective machine.

War is now over, but the new corporation has not lost its interest in aeronautical work. It hopes to apply its war experience to peace aviation. It is keeping in close touch with the aeronautical situation, and is in a position to contribute to the peace growth of the industry which the war has developed from infancy to a sudden maturity.



Office Building (on the left) and Wing Assembly and Covering Buildings (on the right) of the Sturtevant Aeroplane Company



The Sturtevant Battle Plane

THE STURTEVANT AEROPLANE COMPANY

BOSTON, MASS.

NOBLE FOSS *President*
 BENJAMIN S. FOSS *Vice-President*
 W. EMERSON BARRETT *Treasurer*
 ELBRIDGE G. DAVIS *Secretary*

Directors

NOBLE FOSS W. EMERSON BARRETT
 BENJAMIN S. FOSS ERNEST B. FREEMAN
 ELBRIDGE G. DAVIS

PLANT NO. 1—Located at Jamaica Plain Station.

PLANT NO. 2—Located facing on Union Avenue.

THE STURTEVANT AEROPLANE COMPANY was organized in 1915 by Noble Foss. With him were associated his brother Benjamin S. Foss, the aeronautical designer Grover C. Loening, and others. A fire had destroyed a portion of the B. F. Sturtevant plant, but some buildings remained, and it was in one of them, the present "Building B" of the company, that the new association launched itself. There were 24,000 square feet in which to operate, and for a time this was sufficient.

Soon, however, the company was successful in securing contracts from the Army and Navy. The twenty-five or more machines



Plant 1 on the right, and Plant 2 on the left in the background; between them the private way for storing packing crates



Side View of the Battle Plane

which were eventually built prior to the war demanded the erection of another building especially designed for airplane work. The two buildings constituted the factory in which the modest government orders were fulfilled.

The model S-4 seaplane, one of these Sturtevant planes, was a two-seated biplane tractor, designed as an advance training machine. It had a spread of 48 feet 7½ inches, chord 7 feet, gap 6 feet, no stagger, no retreat, a 4 degree dihedral on the lower wings only. The fuselage was triangular cross section, all steel construction. The radiator was mounted in the upper center section so as to form part of the nosing of the section. The entire empennage was of steel structure, members being made of channel section galvanized iron, lightened out by punching and crimping the edges. The power plant consisted of 150 H. P. model 5-A eight cylinder Sturtevant motor. A Christianson air-starter was also furnished. The gas feed to the carburetor was by gravity, the tank being located between motor and the first seat. Dual "dep" control was employed.

Meanwhile, changes in staff had been occurring which left the new organization with its present officers. Mr. Noble Foss, with his brother, had been incorporators. Both Harvard men, and both connected with the B. F. Sturtevant Company, they had gained a mechanical and business knowledge of extent and value. Mr. Noble Foss had organized the Sturtevant Manufacturing Company



BENJAMIN S. FOSS, NOBLE FOSS, JOHN J. McELROY, W. EMERSON BARRETT,
F. S. CHANONHOUSE



Plant No. 2

in 1910, and had designed and manufactured aeronautical motors until his organization was absorbed in 1915 by the B. F. Sturtevant Company. In the meantime, he had served as secretary and director of the latter corporation. His brother had been connected with the Purchasing, Production, and Accounting Departments of the B. F. Sturtevant Company, had served as Secretary and Director, and as Manager of Foreign Sales and Assistant Treasurer.

In 1916 Mr. W. Emerson Barrett had joined the new organization as Office and Production Manager, and was later to serve as Treasurer. Fred S. Chanonhouse, the present General Superintendent, identified himself with the new company at the same time. He had been Shop and Test Superintendent for the Sturtevant Manufacturing Company since 1912, and before that had built and flown an airplane in connection with J. C. Shoemaker.

John J. McElroy had been associated with the B. F. Sturtevant Company since 1912, first as draftsman, then as Squad Chief, and entered the Sturtevant Aeroplane Company as Chief Draftsman when government work began in 1917. He later became Chief Engineer.

With the declaration of war, the Government made the sharp change of policy which the public knows. Possessing less than a hundred machines, it began planning for thousands. Among its orders was a contract with the Sturtevant for 1,000 sets of JN-4-D spare parts, placed in October, 1917.



Wing Assembly Department



The Rough Mill in the Sturtevant Aeroplane Company's Plant at Jamaica Plain



The Wing Covering Department



Rear End View of Plant No. 1; Rough Mill on the left

Other commissions were to follow. Upon finishing the training machine (JN-4-D) order, 850 sets of DeHaviland battleplane spares were next started, and at the close of hostilities all difficulties had been surmounted and production had become a routine procedure. In addition to the battleplane contract, a small order of 225 complete sets of JN-4-D spares was started and almost completed when the "stop" order was issued.

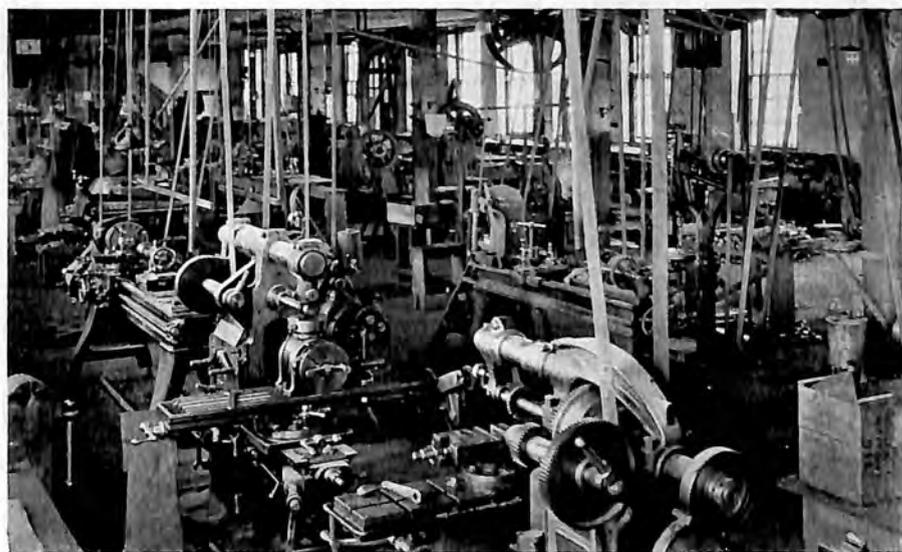
Preliminary work had also been started on the manufacture of an advanced training machine known as the VE-7; 500 complete machines with corresponding number of complete spares were included in this contract.

New buildings were erected as required and old buildings were rebuilt. The total area of these buildings at the close of hostilities approximated 150,000 square feet. This increase in floor area, along with relative increase in employees, from a total of 40 in 1916, to 1,000 in November, 1918, tells the story of the company's growth.

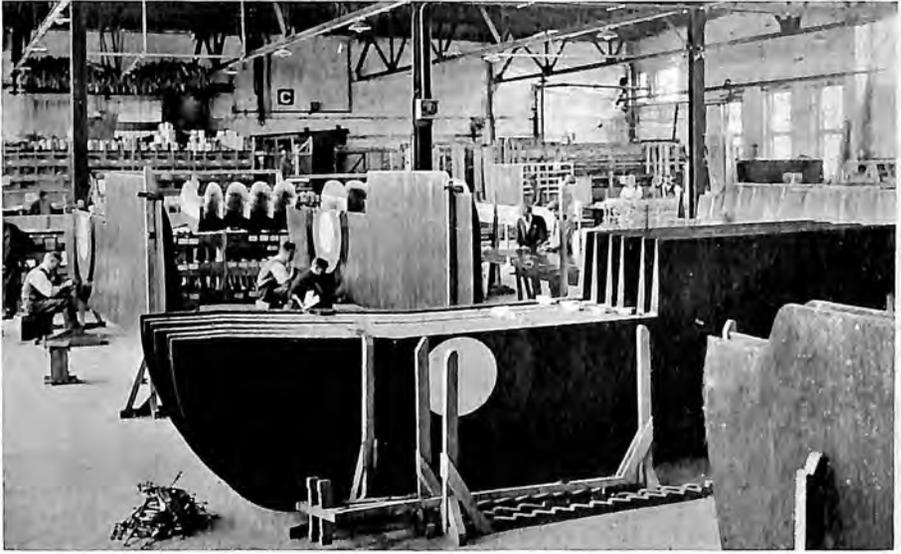
The company produced its war work in two plants which finally totalled nine buildings. The first division, with seven buildings, is located at Jamaica Plain Station and runs parallel with the railroad to Union Street. It comprises the Rough Mill, the Finish Mill, Metal and Wire Shop, and Small Assembly Metal Parts, all in one three-story building—the original company plant; the Assembly Building, the Shipping and Paint and Dope Building; the Pattern



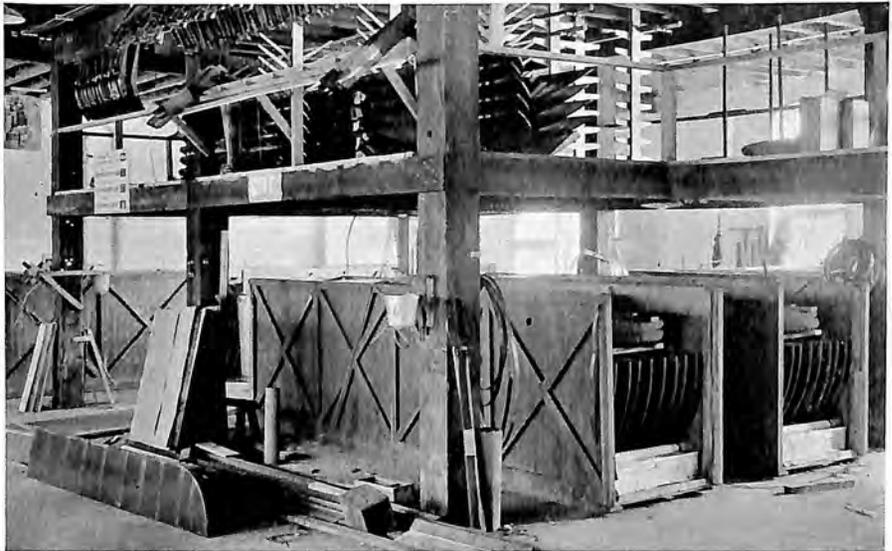
The Finish Mill



Part of the Machine and Metal Shop



Final Assembly Room



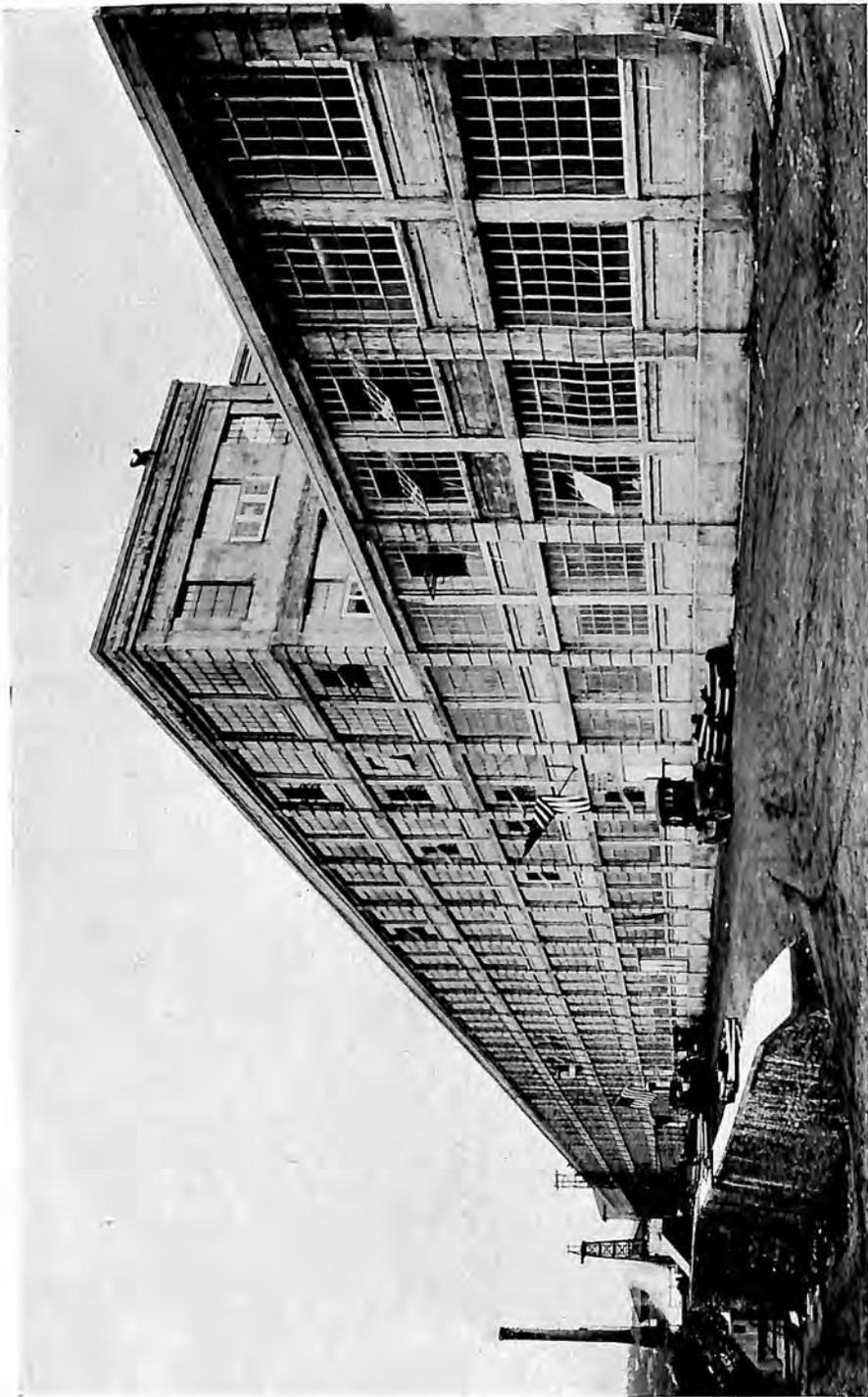
A Corner of the Shipping Room



The Drawing Room

and Jig Shop, the Power Plant, and the Wing Assembly and Covering Building. Plant 2 is separated from the main Plant 1 by a private way and consists of a three-story building adjoining a two-story substructure. This building contains 35,000 square feet.

At the close of hostilities there were over 1,000 employees at the two plants. A band of thirty pieces had been organized that furnished music at welfare and patriotic meetings. Every convenience was considered by the management to help make the plant attractive to its employees, and the results were gratifying in both the grade of work produced and the absence of labor difficulties within the plant.



The Thomas-Morse Aircraft Corporation's Main Plant on South Hill, Ithaca, N. Y.



The Thomas School, with a D-5 Tractor, 135 H. P. Thomas Motor in the foreground

THOMAS-MORSE AIRCRAFT CORPORATION

ITHACA, N. Y.

F. L. MORSE	<i>President</i>
W. T. THOMAS	<i>Vice-President</i>
J. A. FRIED	<i>Treasurer</i>
RAYMOND WARE	<i>Secretary</i>

Directors

F. L. MORSE	J. A. FRIED
W. T. THOMAS	D. B. PERRY
E. T. TURNER	

MAIN PLANT—South Hill, Ithaca, N. Y.

AUXILIARY PARTS PLANT—Brindley Street, Ithaca, N. Y.

EXPERIMENTAL PLANT—Center Street, Ithaca, N. Y.

IN December, 1914, the citizens of Ithaca, New York, were startled by the rumor that a "flying machine" factory had arrived at their little city. It was even asserted that a flying school had arrived with it, at which young men, certainly not of normal mind and character, were endeavoring to achieve the art of propelling themselves through the air with safety and precision.

Rumor was correct. The Thomas Brothers Aeroplane Company and the Thomas School of Aviation had established themselves at the foot of Lake Cayuga.

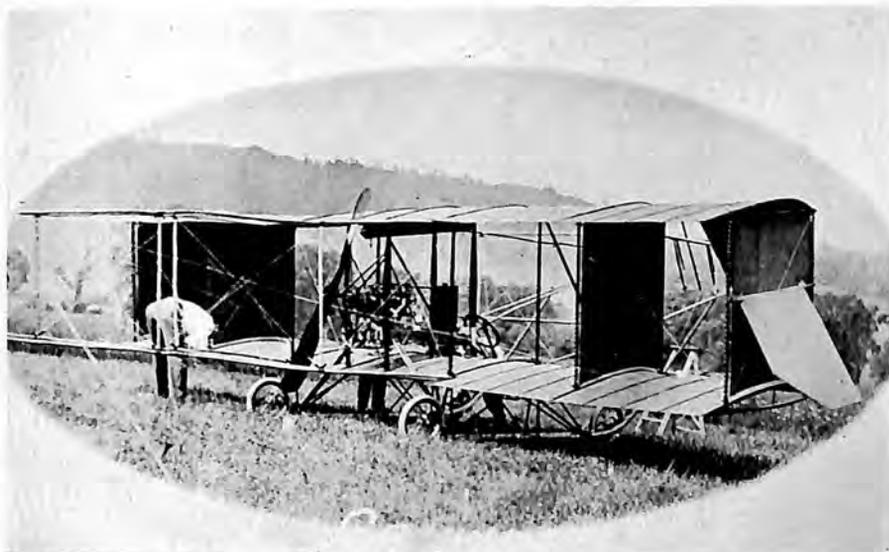


The Experimental Plant

Both began work; the Aeroplane Company built motors and machines; the school sent its remarkable young men into the sky. And the amazement of Ithaca, though growing no less, took a respectful tone as it was learned that the Thomas Airplanes were being sold in far-off England as well as in the United States, and that these wild young men were becoming noted teachers or daring practicers of flying. Why, one of them, Frank H. Burnside, held the American altitude record, Walter E. Johnson, of the same brood, had flown longer with a passenger than any other American flyer. And another, Charles F. Niles, was starting aviation in Mexico as a government instructor.

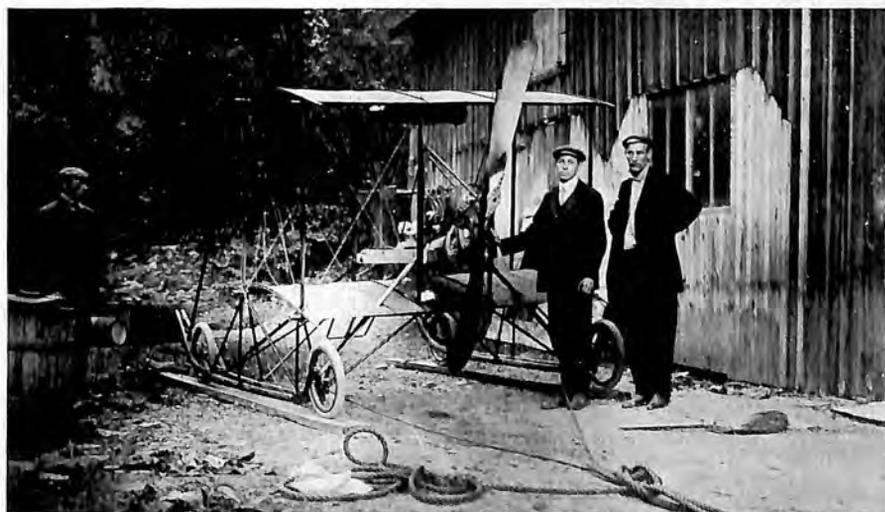
The fact was that the Thomas companies had already achieved a considerable growth and reputation when they descended upon Ithaca. They had been pioneers in aviation. In 1908 a young man by the name of W. T. Thomas had graduated from the Central Technical College of London, England, as a mechanical engineer. He had dreams of building a machine by which flying, precarious and undeveloped, and indeed hardly known, would become a practicable and useful thing. His dreams took him to America, where, at Hammondsport, New York, he worked on the designs of motorcycles and aeronautical engines with Glenn H. Curtiss and with Captain Thomas Baldwin.

Soon, however, he and his brother Oliver W. Thomas began

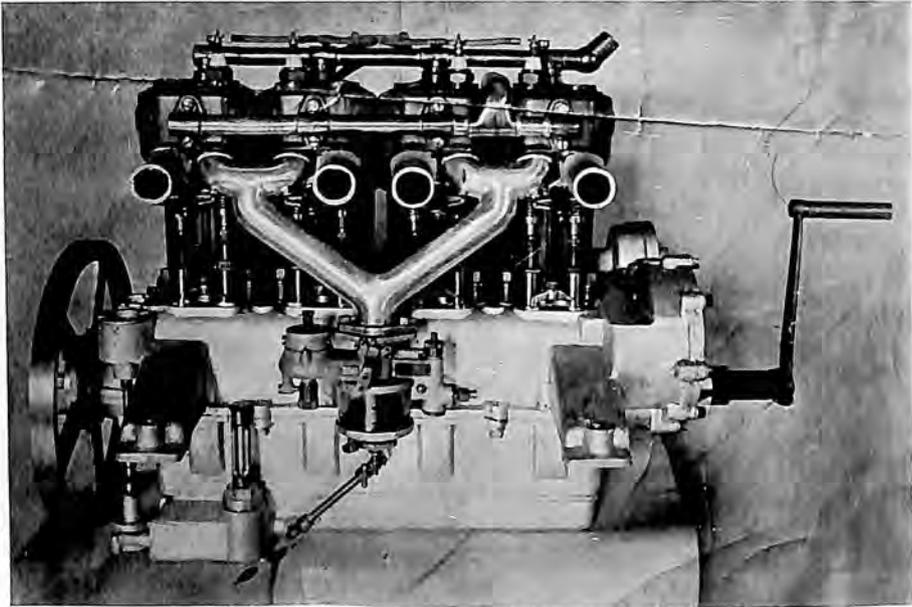


The Original Machine, 1910

experiments of their own. They founded a company in Hammondsport under the name of Thomas Brothers. Their first machine was built in 1910. It was constructed in a barn by Mr. W. T. Thomas and two mechanics,—a slow labor of months. Even the sanguine pioneer constructor could have had no idea that when, seven years later, his country was to be locked in the greatest struggle it had ever



Power Plant and Undercarriage of Original Machine



Original Engine, 22 H. P. Kirkham Automobile Type

undertaken he was to supply it with many of its speediest training machines.

The Thomas Brothers did not remain long in Hammondsport. They moved to Hornell, and soon afterward to Bath, New York, where their work was to have a vigorous growth.

At Bath, in 1912, the Thomas Brothers Aeroplane Company and the Thomas School of Aviation were incorporated by W. T. Thomas, Oliver W. Thomas, Cummings M. Cox, and Walter E. Johnson. Frank H. Burnside was one of the pupils of the school, but he soon passed from pupil to chief pilot for the company, and in 1913 broke the altitude record then held by Lincoln Beachey by reaching an aerial height of 13,000 feet.

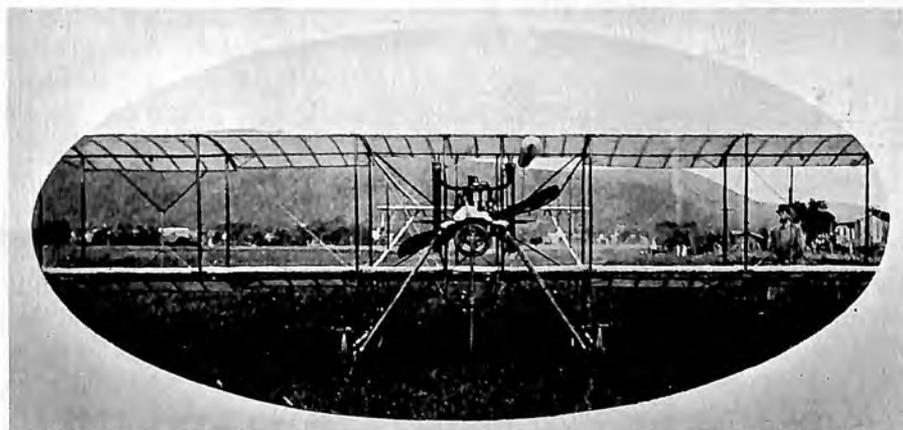
The Hammondsport model of 1909-10 had made an excellent showing for its day. Fitted with a 22 horse power engine, it had the unique arrangement of chain-driven propeller, geared $1\frac{1}{2}:1$, and an undercarriage with four wheels mounted on skids through the medium of light cantilever leaf springs. At first, the machine employed side panels in conjunction with ailerons for lateral control; alterations were subsequently made involving the use of ailerons of a more conventional type than those at first incorporated by Mr. Thomas. A 22 horse power Kirkham automobile engine drove the



Walter Johnson in flight

machine. Flights lasting as long as twenty minutes were made, and a passenger was carried. In 1910 the experimenters abandoned the chain-driven mechanism and employed a high-speed direct propeller. The brothers had by this time moved to Bath and their first machine was often seen skimming the ice of Salubria Lake.

At Bath a new model, the TA, supplanted the pioneer machine. The new craft was propelled by a 6-cylinder Kirkham aeronautical motor, and carried as many as three passengers (pilot included),—a marvellous load for 1911. Moreover, it showed an amphibious



Model TA, with a 50 H. P. Kirkham Engine



Model TA in flight

nature. Pontoons were fitted to it, and the airplane became a hydro-airplane, rising easily from the water and at times carrying a passenger.

A tractor model of the TA proved oddly unsuccessful. The tractor is, to-day, the only type in general use. Its advantages, however, were not apparent in this 1912 adaptation of the TA pusher, as its performance with the same wings and engine was below that of the earlier craft. Better results came from a special exhibition machine produced in the fall of 1912. The original plane carried a 50 horse power Kirkham motor. With a model slightly altered and carrying a 65 horse power motor Walter E. Johnson made his American endurance record at Bath on October 31, 1912, carrying a passenger for three hours and fifty-one minutes. It was likewise essentially the same Thomas design, strengthened by the addition of an 80 H. P. Curtiss, which carried Frank Burnside to 13,000 feet and a new altitude record in June, 1913.

Other interesting machines were built by the zealous experimenters. A monoplane fitted with a 60 H. P., 4-cylinder Maximotor was constructed and flown in 1913. Two Nacelle type pushers, one with a 90 H. P. Austro Daimler motor, appeared, and both proved strong flyers. Several flying boats were designed and constructed during 1912 and 1913, two with the novelty of metal hulls,—30-gauge galvanized iron covering a light wooden framework, and reinforced with wooden planking at the front and on the bottom.

While this work was going forward the company received an



Model E

addition to its staff, in Mr. B. D. Thomas, who became Chief Engineer and Airplane designer.

He had had a distinctive apprenticeship. When he graduated from King's College, London, it was to serve Messrs. Vickers, Ltd., finally, as assistant designer of aircraft. He passed from this house to the Sopwith Aviation Co., famous now since the war has developed the remarkable Sopwith wing. Glenn H. Curtiss met him in Paris, and asked him to come to Hammondsport. Here he assisted in designing model J tractor for the Curtiss Co., and later planned the "America" flying boat in conjunction with Lieutenant Porte. Later joining the Thomas Company, he designed the T2 tractor biplane.

This machine carried the Thomas name across the Atlantic. Its speed of 83 M. P. H. and climb of 3,800 feet in 10 minutes with pilot, passenger, and 1,000 pound load impressed the British Admiralty, and an order for 24 planes was given the American firm.

The Company and the School had thus a backing of no little prestige when they startled the collegiate quiet of Ithaca with the hum of their motors.

Ithaca was a natural choice for a new location. The ground at the base of Lake Cayuga affords flat fields for airplane landing fields, while the lake, extending northward for forty miles from Ithaca, invites experiment with the flying ship or hydro-airplane. At the same time the situation is not a too accessible one for the public,



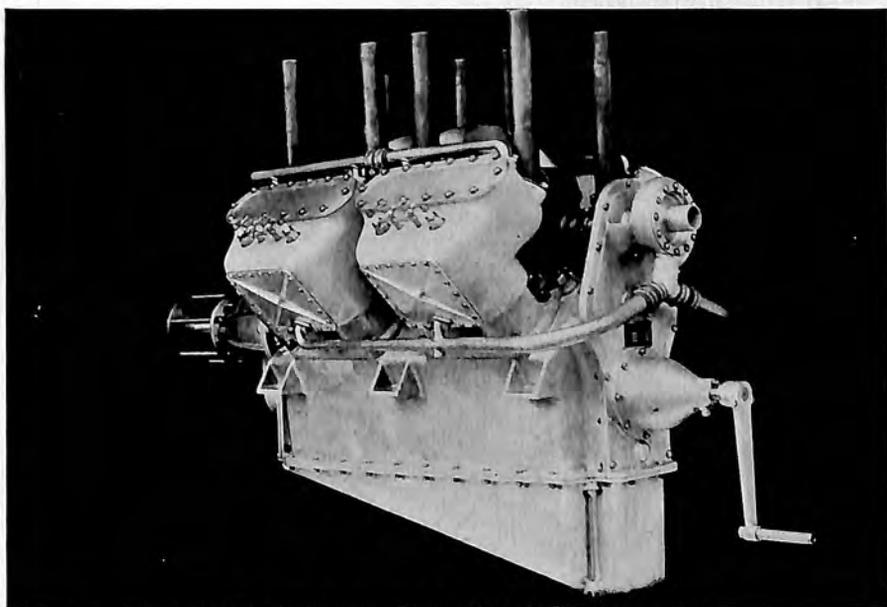
Nacelle Machine, Three-Place



Monoplane, fitted with 50 H. P. Maximotor



A One-Place Nacelle Type



The 135 H. P., 8-Cylinder Thomas Engine No. 1



Model T-2 fitted with 90 H. P. Austro-Daimler Engine

and has the advantage of glorious scenery and a cold winter which permits flying from ice.

The move to Ithaca was marked by the appearance of the D2 tractor, another of Mr. B. D. Thomas's designs. The T2 had been probably the best performing machine in the United States at the time of its production, but its speed of 83 miles per hour was smashed by its successor, which established an unofficial record of 95 M. P. H. and a climb of 4,500 feet in 10 minutes. One of the factors in its success was doubtless the 135 H. P. Thomas geared engine.

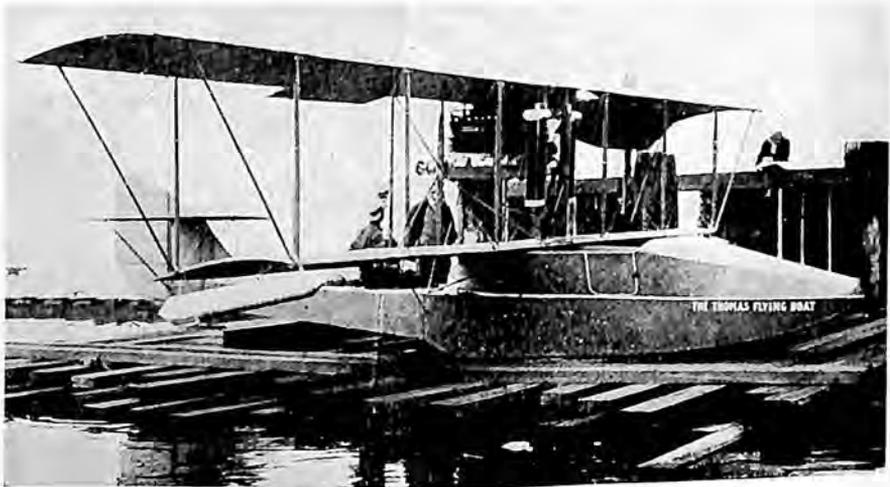
The new motor was the work of two men who had just joined the



Model D-2 Two-Place Tractor with 135 H. P. Thomas Engine



The Original Thomas Flying Boat with 65 H. P. engine

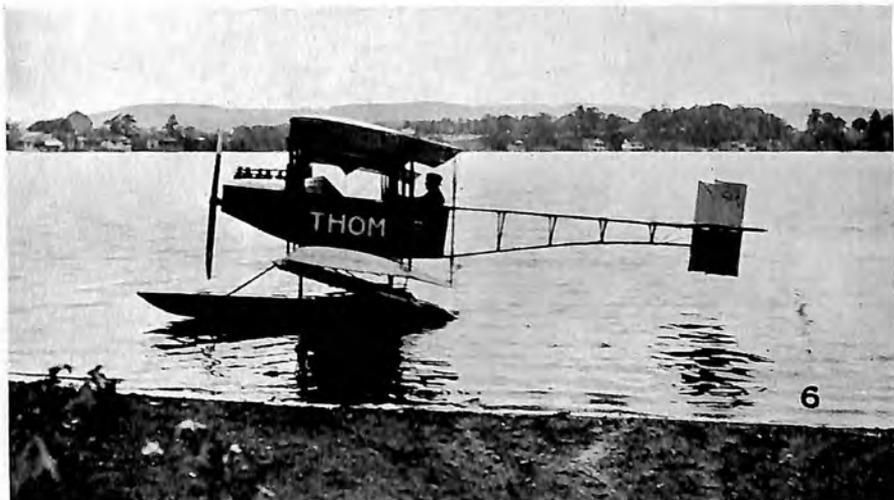


Flying Boat No. 2, with Steel Hull and 90 H. P. Austro-Daimler Engine

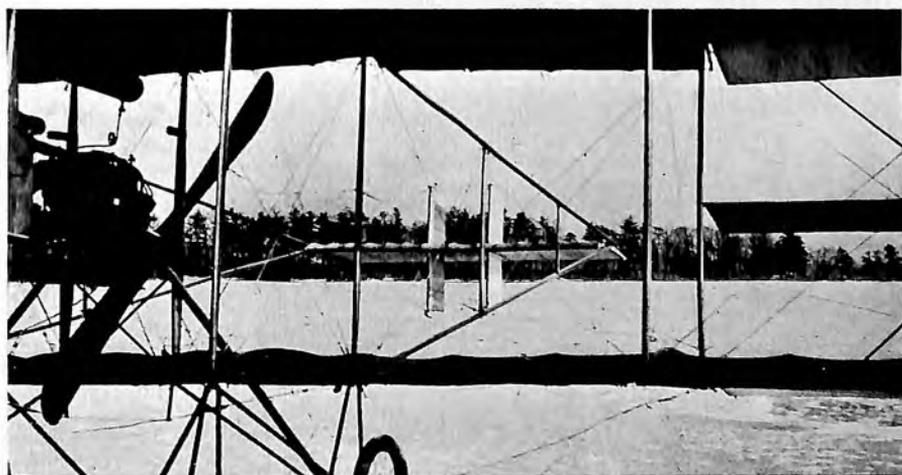
company, or, rather, had been among the founders of the auxiliary Thomas Aeromotor firm on August 5, 1915. Both of these, Mr. George H. Abel, now Production Engineer of the Thomas-Morse Aircraft Corporation, and Mr. Harold N. Bliss, Production Expert, had been associated with the B. F. Sturtevant Co., and had helped to design the Sturtevant airplane engine in 1914. Mr. Abel had graduated from the Massachusetts Institute of Technology, and had attended Johns Hopkins University at Baltimore. Later he was to design the 8-cylinder aluminum, 270 H. P. Thomas-Morse engine, model 90, which was given up only after the Liberty had begun its quantity production. The first motor which Mr. Abel and Mr. Bliss produced was likewise an 8-cylinder type, and used a geared down propeller shaft.

Thomas engines began now to be used regularly by the Thomas Aeroplane Company in its flying craft. Two seaplanes were constructed for the naval department in 1915 with 140 H. P. power plant, and justified the introduction of the new engines by attaining a speed of 82 miles per hour and mounting to 2,700 feet in 10 minutes, with passenger, pilot, and fuel for four hours. Soon after their completion, model D5 was built for the Signal Corps. Its 135 H. P. engine drove it at a speed of 86 miles an hour, and permitted a climb of 3,600 feet in 10 minutes with a full load.

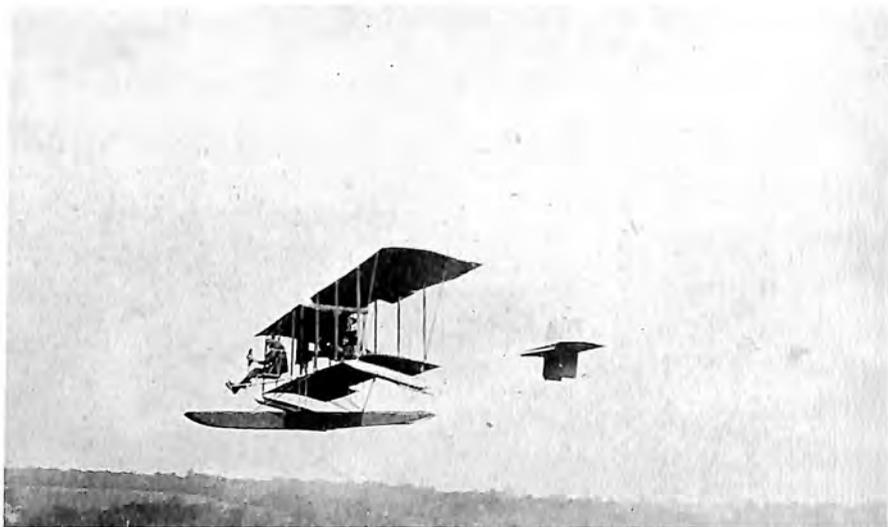
The government was now reorganizing its small flying sections, and came to the Thomas Aeroplane Company for machines. In August, 1916, a two-seater training hydro-airplane was ready for



TA Tractor on Pontoons, with 50 H. P. Kirkham Engine



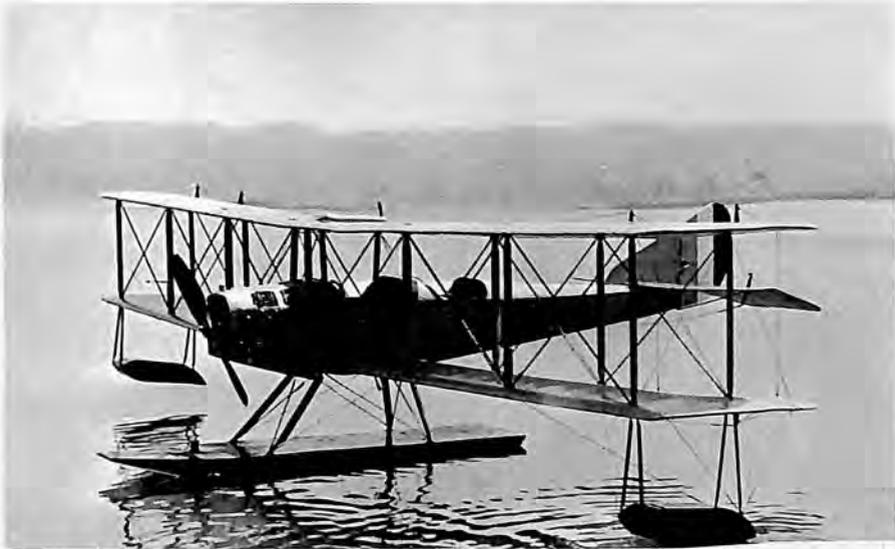
A Modification of the Original Thomas Machine



Model E, with Pontoons



Tractor D-5



SH-4 Hydro-aeroplane

exhibition, and 15 of these SH-4's were supplied the navy. Canada had meanwhile turned to the Thomas School of Aviation as a desirable aid, and the fact that a graduate of the school could receive a commission in the Royal Flying Corps soon brought a number of young men from the Dominion to the southern end of Lake Cayuga. A two-place training seaplane was developed to train both these and young American aviators.

The time now seemed ripe for merging the airplane, motor and educational divisions of the plant's activity into a single industrial unit. On January 31, 1917, this was effected by the incorporation of the Thomas-Morse Aircraft Corporation, providing ample capital and facilities through the connection with the Morse Chain Company of Ithaca, N. Y.

The reorganized company pushed what it had already begun—the construction of a single-seat Scout for training purposes. As it happened, war was not far off, and this machine marked the interest of one of the oldest of aviation companies in one of the most delicate and specialized types of work—production of the high-speed fighter type.

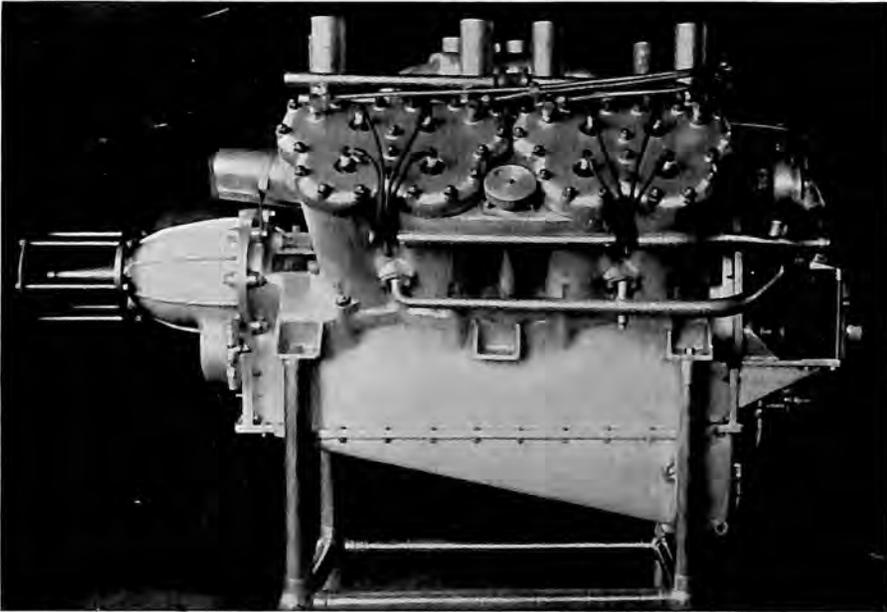
The first model, S-4-B, was fitted with a 100 H. P. Monosoupape Gnome Engine, and reached a high speed of 95 M. P. H. and a climb of 7,500 feet in 10 minutes. Its capacity for manoeuvring was excellent and its strength remarkable. The S-4-C was nevertheless



SH Seaplane Float, with 140 H. P. Sturtevant Engine



Model B Flying Boat (steel hull) making a flight



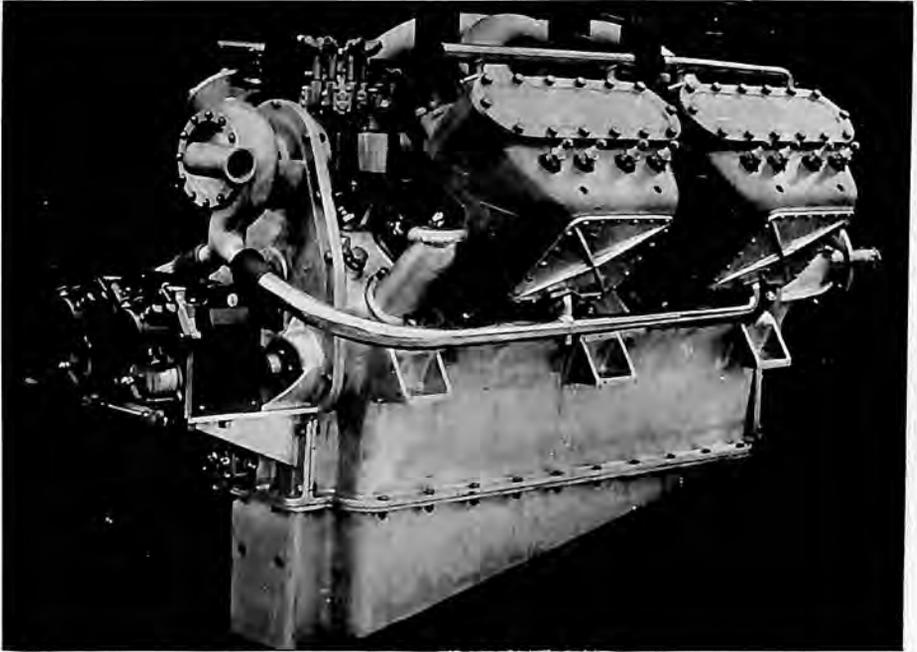
The Thomas-Morse No. 8 Model, with Dual Magneto Ignition and Christiensen Self-starter

constructed to better its performance, and succeeded. It climbed 8,500 feet in 10 minutes, and reached a high speed of 104 miles per hour. The chief change in type involved a shortening of the fuselage.

Any frequenter of American flying fields has doubtless heard the high-pitched hum of these diminutive planes, and seen them slanted at an almost vertical position in a rapid dart toward the sun. The efficient training which American pursuit pilots carried to France was in no small part due to the Thomas-Morse scouts.

Orders for these machines, of course, began coming in after the declaration of hostilities, and eventually the production of Scout Training Types taxed the capacity of the Thomas-Morse factory. A total of \$4,177,000 was received for the war work of a force at times reaching to 1,200 employees.

At the same time that the army Scouts were being developed a kind of naval twin to the S-4-B was constructed in the hydro-airplane S-5. It developed a speed of 90 miles an hour and a climb of 4,500 feet in 10 minutes. It was used in numbers by the Navy Aviation Section. And type S-4-C, with its rigid tubular aileron control and its mounting for a synchronized gunnery equipment, came to share in the popularity which model S-4-B had developed. The final word on the Scout Training Plane was spoken in model S-4-E,

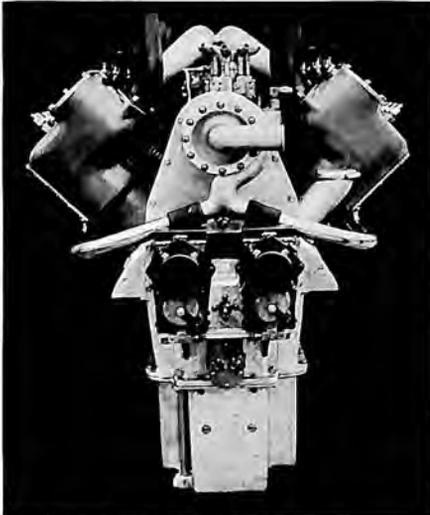


Thomas-Morse Model 8, side view

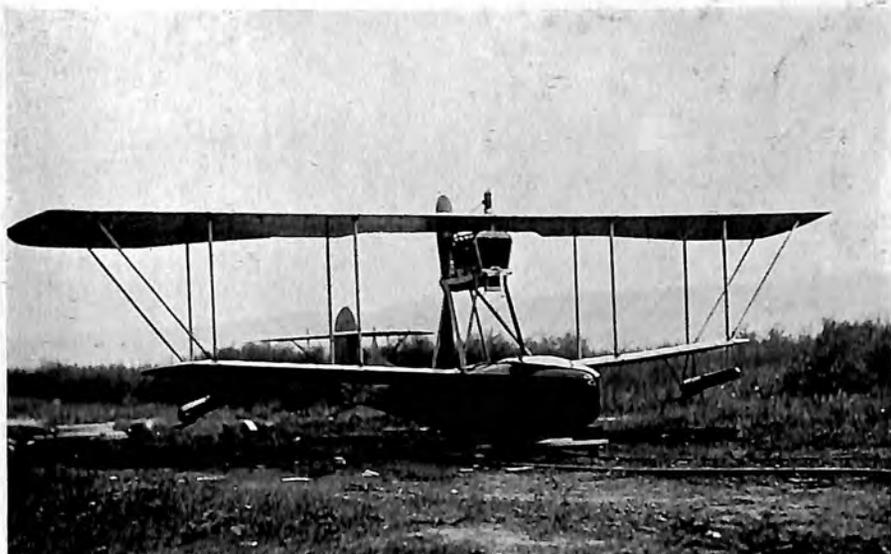
however, which with an 80 H. P. Le Rhone motor reached a speed of 104 miles an hour and a climb of 7,000 feet in the regulation 10 minutes.

An important contribution to military aviation was made in the two-seat fighter types, the MB-1 and MB-2. These planes were built around the Liberty engine, the MB-1 around a 400 H. P. motor and the MB-2 around a 450 H. P. type. The latter engine is geared down. Both of MB types carried a full gunnery equipment.

The work of some of the men who have made the Thomas-Morse Company known in the aviation world has been a part of this history of the company. But there are others whose work has not been noted. One of the earliest Thomas students was Ralph



Front view of same model



B-3 Flying Boat



D-2 Hydro-aeroplane, with Thomas 135 H. P. Engine



Model TA, with Pontoons, rising from the water for a flight



S-4 Scout, One-Place, with 100 H. P. Gnome Engine



S-4-B Scout Type. The Thomas-Morse Scouts were seen on every Advanced Training Field in the United States



S-4-C Scout Type, with 80 H. P. LeRhône Engine



Scout Model S-4-E



S-5 Scout, One Place, Twin Float, Hydro-aeroplane, 100 H. P. Gnome Engine



MB-1 Fighter, Two-Place, with 450 H. P. Liberty Engine



MB-2 Fighter, Two-Place, with 450 Geared Liberty Engine



THOMAS-MORSE OFFICERS

From left to right: Top row, RALPH M. BROWN and JEROME A. FRIED; second row, WILLIAM T. THOMAS and GEORGE H. ABEL; third row, B. DOUGLAS THOMAS and FRANK L. MORSE; bottom row, HAROLD N. BLISS, RAYMOND WARE and FRANK H. BURNSIDE.

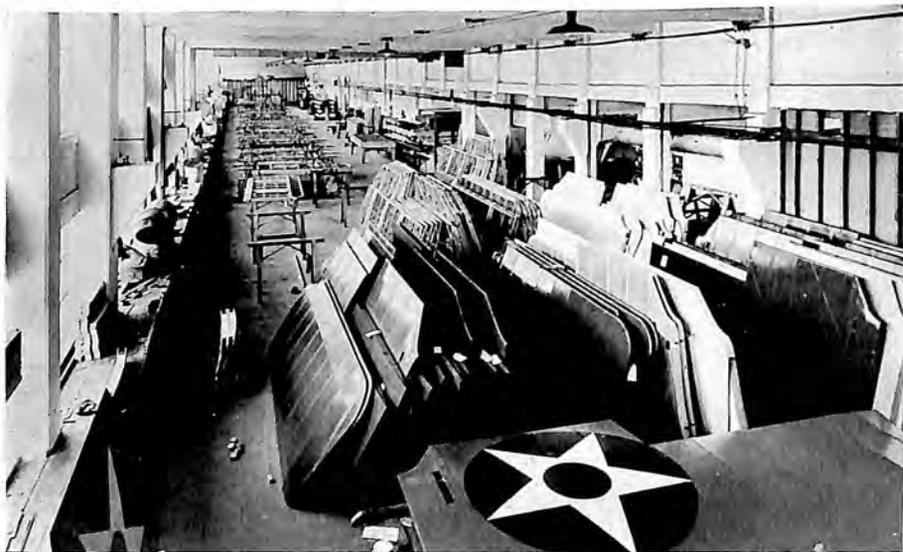


Thomas-Morse Scout S-4-C, Winning from Louis Chevrolet in 140 H. P. Frontenac Car, Belmont Park, September, 1918

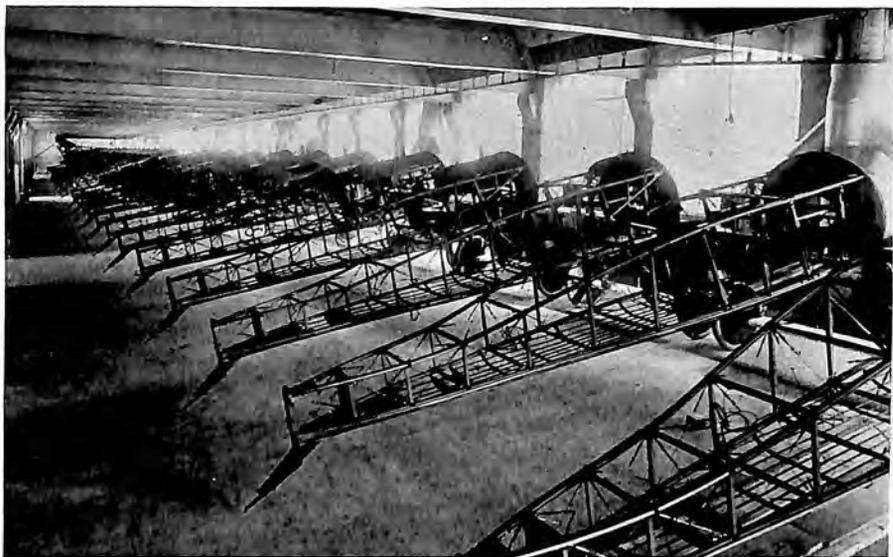
M. Brown, who learned to fly at Bath in 1912. He was engaged by those who had taught him, and has served the company as aviator and as airplane constructor. The Model E pusher biplane and flying boats B2 and B3 were his design largely. From 1915 to August, 1918, he was factory superintendent of the airplane department of the Thomas Companies.

Mr. J. A. Fried was one of the incorporators of the Thomas Aeromotor Company in 1915. Originally in the 1906 class at Columbia, he left before the completion of his course, to enter Cornell University after an interum of business experience, and to graduate from this college as mechanical engineer in 1910. For three years he taught at his alma mater, and for the two following carried on research work in the United States and abroad on the Humphrey Gas Pump and Diesel Engines. Treasurer of the Thomas Aeromotor Co., he has fulfilled the duties of that office under the Thomas-Morse Aircraft Corporation, eventually becoming general superintendent.

A graduate of the Massachusetts Institute of Technology in 1907,



Wing Room in the Main Plant



S-4-B Machines in process of construction, January 1, 1918



Engine Assembling Department

Mr. Raymond Ware has acquired the mechanical experience and the business outlook to fit him for the work of Sales Manager and Secretary to the corporation. He served in the same double capacity in the Thomas Aeromotor Co., and in the Thomas Brothers Aeroplane Company. Office interests have not checked his practical mechanical activity; he has followed closely the development of airplane engines and airplanes, and has taken out several patents in connection with sleeve valve engines.

At the edge of Ithaca you will find the Thomas-Morse plant with its three buildings and a flying field. The Hill Plant with its four-story concrete construction and its 120,000 square feet of floor space, with modern heating and ventilation, an extension of the Morse Chain Co., carries on all assembling, metal machine work and engine building.

The Inlet plant, of frame construction covering 60,000 square feet, is busy with the manufacturing of airplane parts, especially those requiring hand work, and under its monstrous elms the Experimental Plant, with 10,000 square feet of space, houses the company's designers.

With a record behind it that leads back to the first days of American aviation success, the Thomas-Morse Aircraft Corporation lies there by the lake water, equipped for building machines which can fly safely and swiftly over land and sea, and controlling full capacities



The Brindley Street Plant



S-4-B Machines in Assembly Process

for testing its products and for teaching men how to use them. The future of the aircraft industry is dramatically uncertain. It may entail a period of quiet, it may bring an almost immediate expansion which will keep every aircraft firm at a wartime speed. Whatever it holds it will find the Thomas-Morse factories ready to meet every condition. They began with the beginning. They have constantly led in devising new types and in building these types well. Pioneers in days of difficulty, they are more than ever ready to push forward with the aircraft industry, equipped to anticipate its demands and to meet them with skill and strength developed by long and successful experience.



GEORGE H. HOUSTON
President, Wright-Martin Aircraft Corporation

WRIGHT-MARTIN AIRCRAFT CORPORATION

NEW BRUNSWICK, N. J.

GEORGE H. HOUSTON *President*
WILLIAM F. MCGUIRE *Vice-President* (Manufacturing)
HENRY M. CRANE (*Vice-President* (Engineering))
J. H. ANDERSON *Vice-President* (Finance and Accounting)
RICHARD F. HOYT *Secretary*
PRESCOTT BIGELOW, JR. *Asst. Secretary*
A. W. LISHAWA *Treasurer*
EUGENE F. SEAL *Asst. Treasurer*

Directors

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FREDERICK W. ALLEN	RICHARD F. HOYT
JOHN F. ALVORD	CLARK S. JENNISON
T. L. CHADBOURNE, JR.	WILLIAM F. MCGUIRE
MARSHALL L. DODGE	T. FRANK MANVILLE
HARVEY D. GIBSON	GEORGE Q. PALMER
ROBERT E. GRAHAM	HOBART J. PARK
CHARLES HAYDEN	W. HINCKLE SMITH
HENRY R. SUTPHEN	

Subsidiary Companies

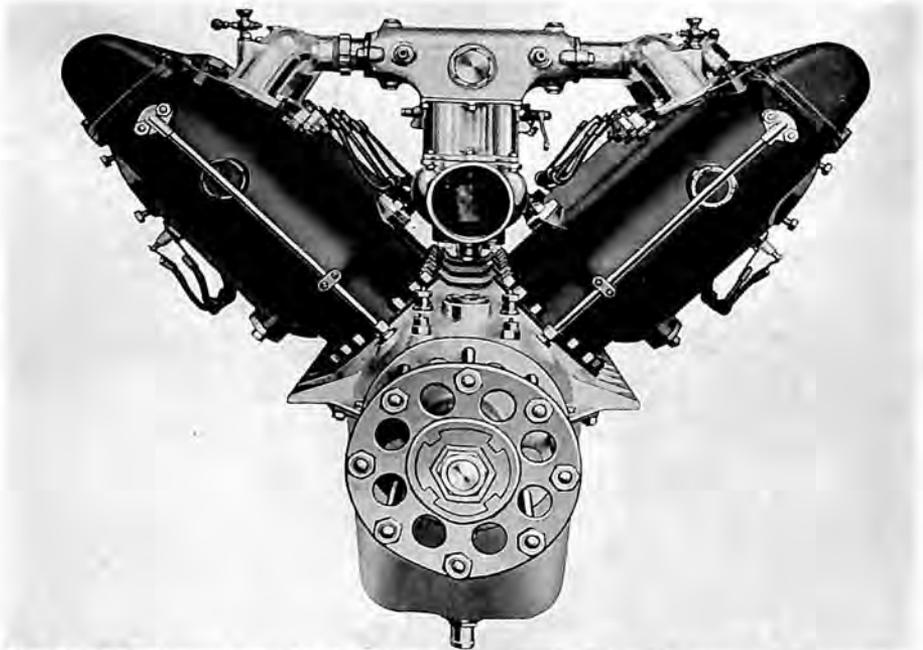
SIMPLEX AUTOMOBILE COMPANY
GENERAL AERONAUTIC COMPANY OF AMERICA
WRIGHT-MARTIN AIRCRAFT CORPORATION OF CALIFORNIA
WRIGHT FLYING FIELD, INC.

LOCATION OF PLANTS—New Brunswick, N. J.
Long Island City, N. Y.
Newark, N. J.

IN the autumn of 1914 it had become obvious that the German Mercedes aviation motor was better than any engine possessed by either France or England.

This fired many engineers of allied sympathies with the ambition to build a motor to surpass the Mercedes, and one of the first actually to start was Marc Birkight, a Swiss engineer, who got to work on his drawings a month after the war's beginning.

Birkight was engineer to the Hispano-Suiza Co., builders of automobiles with plants at Barcelona, Spain, and in Paris, but he was much more than a motor designer. Having a wide experience in machine tool construction, Birkight designed his motor with quantity manufacture considered together with performance. He

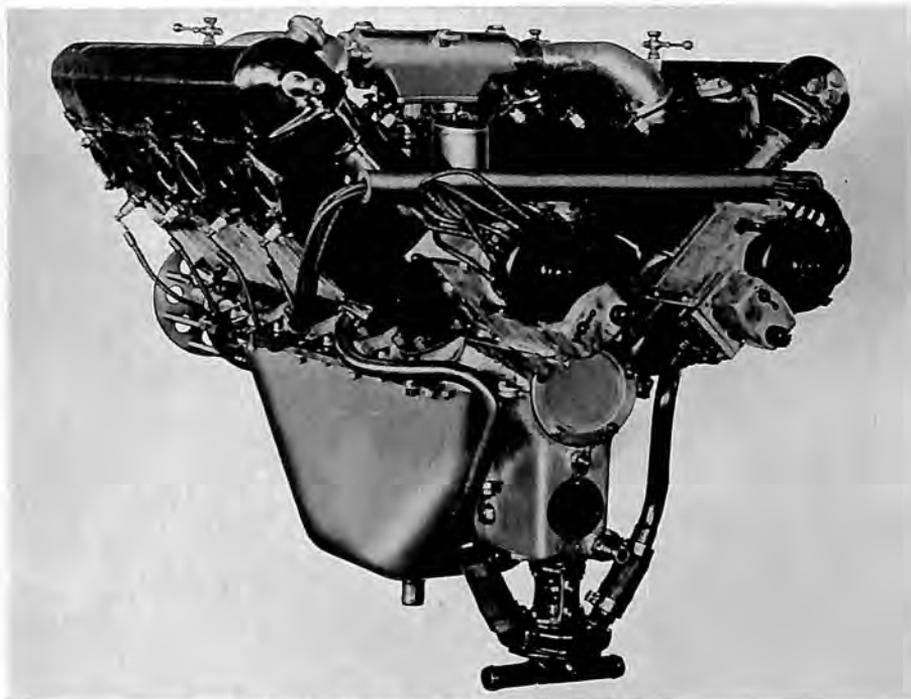


The Original Hispano-Suiza, 150 H. P. Engine Built by the Wright-Martin Aircraft Corporation for the French Government

produced an engine which would do the work better than anything else, and was also easier to make than any other.

In the summer of 1915, the first motor was given to the French army for test, and ran fifteen hours, showing a power for its weight which was very remarkable in those days. Following this test, two more engines were run for fifty hours each and both stood up and maintained their power. These motors were capable of delivering 150 horse power continuously, while most of the engines used by the allies gave around 90 horse power.

At the end of 1915 the Paris factory of the Hispano-Suiza Co. began production and it is interesting to note that from that time on the production of essentially the same design of motor increased steadily right up to the end of the war. One after another different factories in France were ordered by the Government to give up their own experimental motors and produce Hispano-Suiza engines. American production began in 1916 and at the end of the war about 25,000 men were directly engaged on American production while there were fourteen big French plants, one British, three Italian, one Spanish, and one Japanese all making this engine.



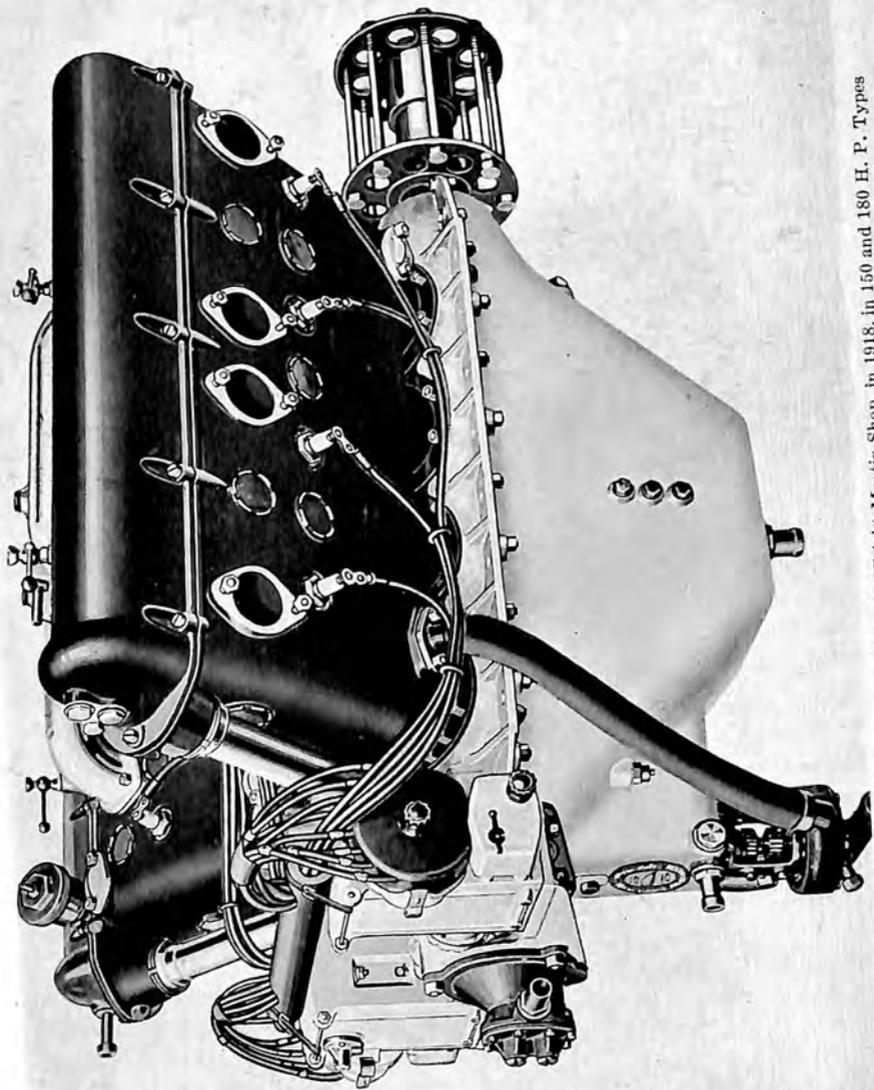
Another View of the Original 150 H. P. Type

This great production was due to the immense success of the engine in single seater combat airplanes which soon proved their superior speed and power when matched against the German machines. Practically all the leading French aces used this motor, beginning with Georges Guynemer, the idol of the French people. Lieutenant Fonck, who surpassed Guynemer's record, Lieutenant Nungesser and dozens more of the best combat flyers of France, England, Italy and America who have used Hispano engines almost exclusively.

It is remarkable that from 1915 onward to the end the engine was but little altered. The original 150 horse power was raised to 180 H. P. and later to 200 H. P., without any changes which interfered with production, in fact it was not until the summer of 1918 that a completely new type appeared, this being the 300 horse power model which was planned to be the dominant fighting machine engine of the Allies in 1919.

AMERICAN DEVELOPMENT

In the early part of 1916 an order for 450 engines was given by the French Government to the General Aeronautic Co. of America,



The Modified Hispano-Suiza Motor, produced by the Wright-Martin Shop, in 1918, in 150 and 180 H. P. Types



Machining line for the Aluminum Water-Jacket Casting in the Wright-Martin Foundry

a subsidiary of the Wright Co., through the Hispano-Suiza Co. of France. This order was the result of a visit made to France by two representatives of these companies, who picked out the Hispano-Suiza as being by far the best of the great number of experimental motors then being tested.

To get into production on this order proved to be very difficult and costly, largely due to the extreme stringency of the specifications on material. It became obvious that a reorganization was necessary, and, in September, 1916, the Wright-Martin Aircraft Corporation was formed to take over the General Aeronautic Co. of America, the Wright Co. and the Simplex Automobile Co.

Even after this event there was considerable delay, and up to July, 1917, less than 100 motors had been shipped to France. The rapid development of the Hispano-Suiza motor in America really dates from May, 1917, when the management of the undertaking was given to the firm of George W. Goethals & Co., Inc., Mr. George H. Houston becoming vice-president and general manager. When the first order came from the United States Government in July, 1917, engines on the French order were being produced at a steadily increasing rate, and the American order was accepted with the certain knowledge that the motors could be shipped within a definite and reasonable time. The end of July, 1917, saw the Wright-Martin Corporation with nearly 1,000 motors on order, all of exactly the



Looking Down one of the sides of the Assembly Floor from the point where the Finished Crankcase starts along the line

same type, and the success of the Hispano-Suiza abroad made it certain that more orders for the same engine, or for a similar one, would be forthcoming, so it was possible to go ahead and schedule for a large organization and a big equipment. One thing which made it difficult, however, was uncertainty as to whether the 150 or the 200 H. P. engine would be wanted, because this to some extent affected the tools and material required. The management very wisely decided to ignore the possibility of changes and went ahead on the assumption that the 150 H. P. engine was going to be wanted all the way through, subsequent events proving the correctness of this view.

The burden fell upon the tool and jig designing department, which had continually to improve the methods of manufacture of the 150 H. P. engine, and at the same time have ready all plans for the 200 H. P. Within a matter of weeks news came from France of an entirely new Hispano-Suiza motor, the 300 H. P., which would if called for, need a manufacturing equipment of which no portion would be identical with that required for either the 150 H. P. or the 200 H. P. This did not yet begin to add to the burden of planning, because it was obviously far from through the experimental stages in France, but it had to be taken into consideration.

From July to November, 1917, was a period of concentration upon the 150 H. P. Mr. Houston gathered around him a very strong

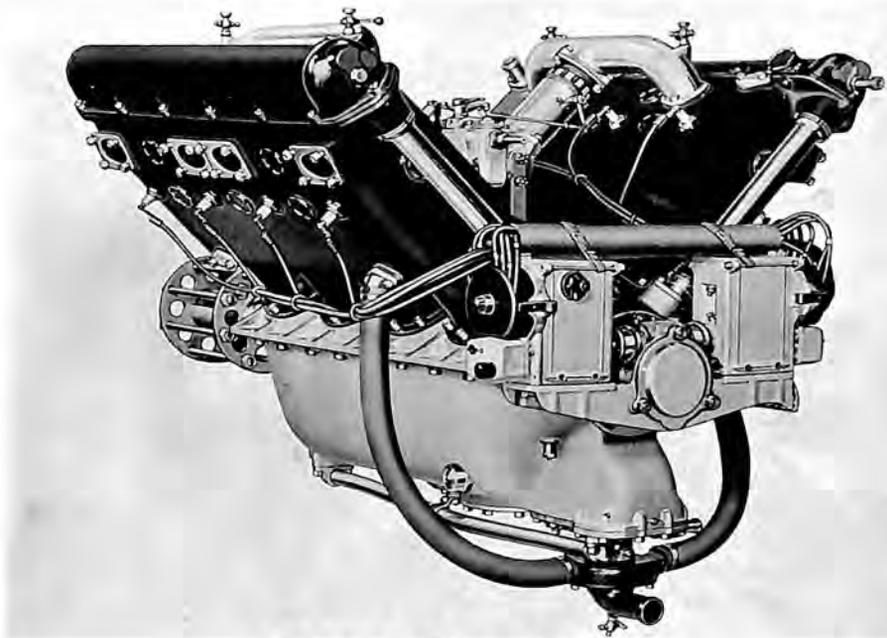


Crankshaft Line in the New Brunswick Factory, exclusively devoted to the 150 and 180 H. P. Motors

executive staff, and by the end of the year had entirely reorganized the factory at New Brunswick, N. J. Some new buildings were erected, the tool equipment was greatly increased, and all the old equipment rearranged so as to get the utmost ease and speed of production.

It must be remembered that in 1917 there were extremely few men in America with any experience of so delicate a manufacturing proposition as an aviation motor, and this made it difficult to obtain much assistance from outside. For example: One of the basic features of the Hispano-Suiza engine is an aluminum casting of considerable delicacy and quite intricate. In Europe the best of the foundries have been unable to produce this part so that it can be machined without previously being repaired by difficult hand work. In America the usual sources of supply of aluminum castings were unwilling to undertake the job, so the Wright-Martin Corporation had to establish its own foundry. This was done to such good purpose that the castings being made in the Autumn of 1917 were infinitely superior in quality to any obtainable in Europe right up to the end of the war. This foundry probably produces the best cast aluminum work in the world.

While the creation of the foundry was the most spectacular of the things done outside of what an engine plant has usually to consider,



The 300 H. P. Wright-Martin Hispano Motor

there were other departments in which abnormal difficulties had to be mastered. In fact every department had to continually struggle with some unusual problem, but despite this, and despite the confusion impossible to avoid in adding to and rearranging a large plant, the production went on steadily increasing.

Coming back to the 300 H. P., this motor had progressed so far in France by November, 1917, that the United States Government informed the Wright-Martin Corporation it would have to be ready to manufacture this type as well as the 150 H. P. The intermediate 200 H. P. model was to be superseded, but the 150 H. P. had now become the leading engine for American training airplanes, and there was no doubt that it would be needed in ever increasing quantities. Information regarding the design of the French 300 H. P. Hispano-Suiza came through very slowly, but the engineering department went ahead on such drawings as they could obtain. Meanwhile the jigs and fixtures were laid out simultaneously, so that no time should be lost.

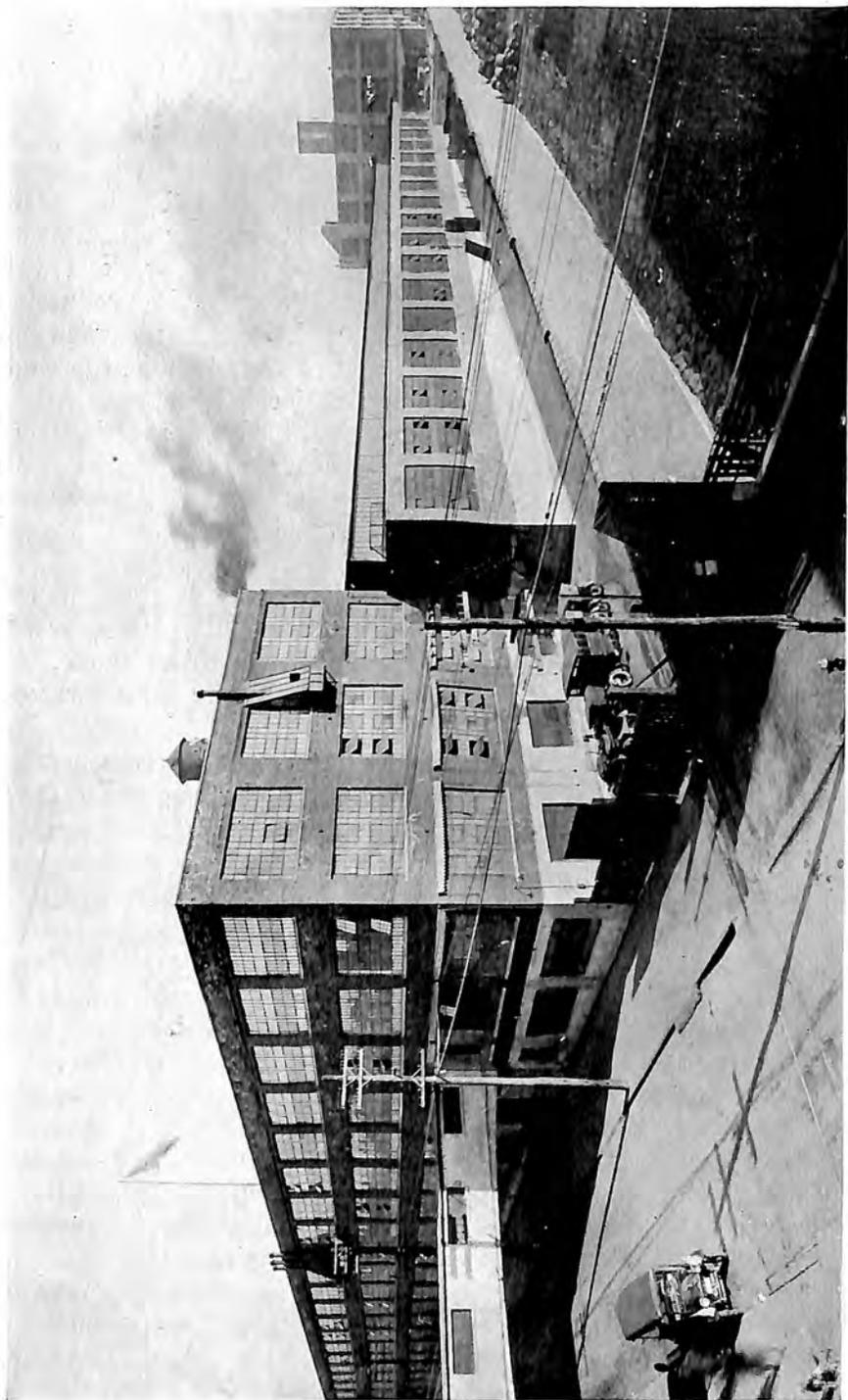
Shortly after this, however, the order given for the 300 H. P. was held up owing to uncertainty as to where the motor would fit into the American aviation program. This provided another problem

to be solved. The natural thing to do perhaps would have been to thankfully drop consideration of the new type and devote every ounce of energy to increasing the output of the smaller motor, but the management considered that the performance of the French engine, as reported, was so good that it would ultimately be called for, so work on getting ready was not completely abandoned, the engineering department continuing experimental work slowly. Thus the dawn of 1918 saw the 150 H. P. really in production in the reorganized plant and the 300 H. P. being carried on slowly. Utilizing what they could get by mail and cable, the engineering staff found a great deal lacking and decided that rather than wait till the French 300 H. P. Hispano was in final shape it would be better to go ahead and complete the design themselves. This they did during the Spring of 1918, introducing some features differing in detail from the French design, but which afterwards proved to be improvements.

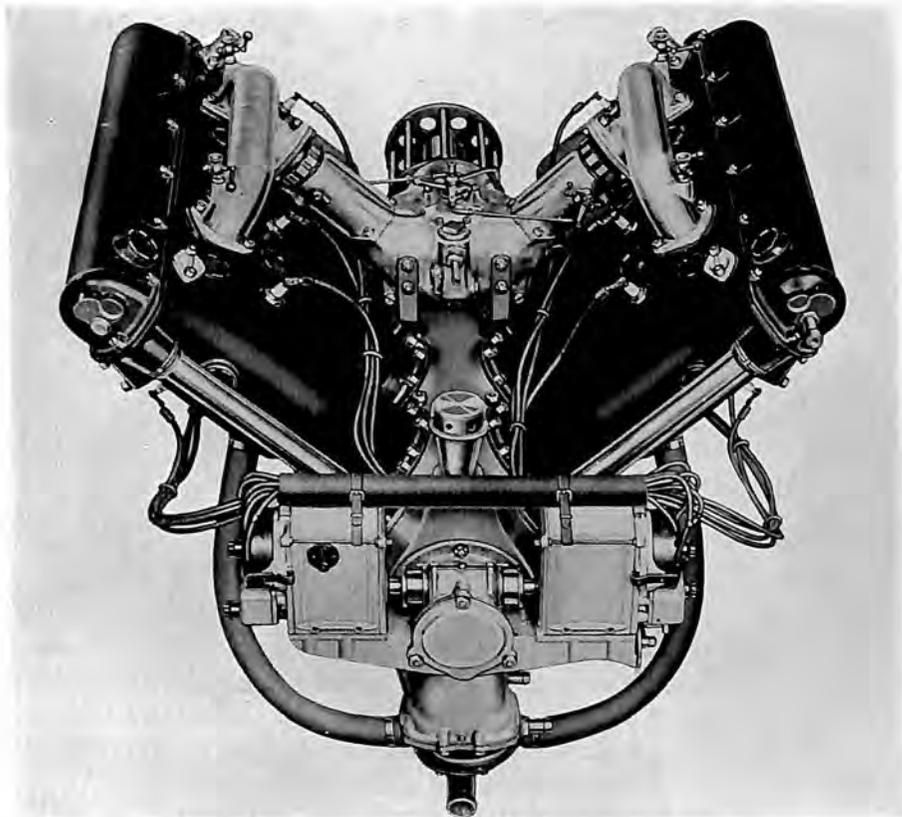
Final tests of this engine gave a very remarkable performance. Shortly afterwards the decision of the French and British governments to utilize the motor in very large quantities was made, and in May, 1918, the Wright-Martin Corporation received authority to put this motor into production in large quantities.

It would have been impracticable to add to the New Brunswick plant in time, so the Government-owned factory in Long Island City, which had formerly belonged to the General Vehicle Co., was given over for the purpose, it and its equipment to remain Government property, but to be operated by the Wright-Martin organization. In May the buildings were taken over. By the middle of July they had been prepared to receive the new equipment. By October large additions had been made, the plant was full of tools and all set for a monthly production of 1,000 motors, a schedule which would have called for nearly 15,000 men and would have been reached early in 1919 had the war continued. The first production engine was actually placed on test in November, 1918.

This in itself would have been considered a sufficiently remarkable achievement in peace time—to take a new factory, organize it on such a scale and have motors coming through within eight months—but it is an amazing record when it is remembered that all the work was done by the New Brunswick organization. The same men who were operating the parent plant at the highest of high pressure and continually boosting its production were simultaneously getting ready the second plant.



Jersey Avenue View of Building B, Wright-Martin Plant, New Brunswick, N. J.



The 300 H. P. Wright-Martin Hispano-Suiza—another view

The necessity for erecting its own foundry has already been mentioned, and during 1918 another side industry had to be installed, this being a shop where the Corporation could make its own gauges and tools. To get an adequate supply from the overloaded tool industry and to get gauges accurate enough for the fine work necessary in an aviation motor had been extremely hard for the 150 H. P. motor. It was obvious that if reliance was placed on outside sources for the tool and gauge equipment for the 300 H. P. there would be much delay and difficulty. So the Wright-Martin gauge plant was set up in Newark, N. J., large enough to take care of both Long Island City and New Brunswick plants.

So much for the way in which the organization was built up. When we turn to look at the results the outstanding fact is that from an Hispano-Suiza motor production of about \$2,000,000 value per year in September, 1917, an increase to about \$50,000,000 per year



One Side of the Foundry which turns out all the Complicated Aluminum Parts of the Hispano-Suiza Motors

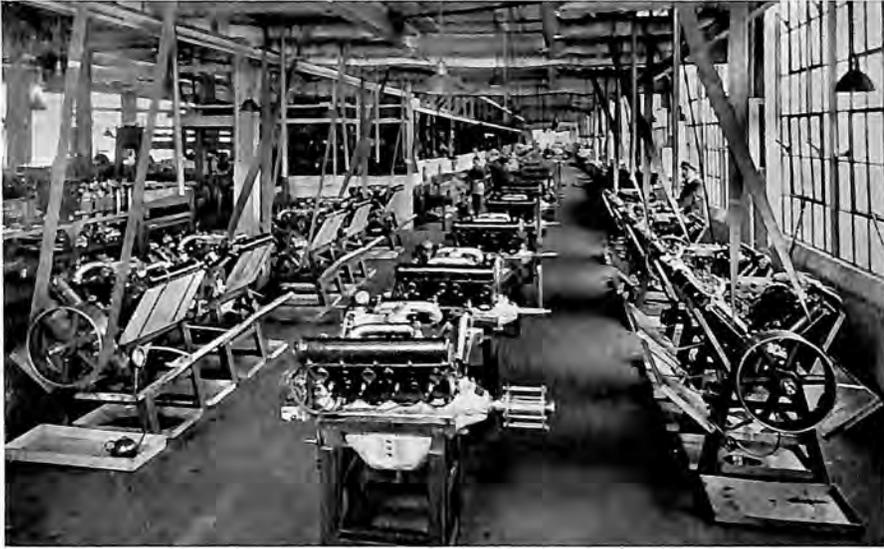
had been made in the New Brunswick factory alone, by October, 1918, and this despite a large decrease in the price paid per motor.

From an order for a few hundred motors on the books in the summer of 1917 the corporation had a schedule for the summer of 1919 calling for all the engines they could make or get help to make—a total of about 2,000 a month and spares. At the declaration of the armistice orders on the books totalled about \$50,000,000.

The production schedule for the 150 H. P. engine at New Brunswick was five motors per day, beginning late in 1917, and in November of that year additional contracts increased this to ten per day, for delivery by Spring. Early in the Spring of 1918 fifteen a day were called for and in August, 1918, the corporation was committed to a schedule of thirty engines a day, this to be reached by January, 1919. As a matter of fact the thirty-a-day output was reached in October, 1918.

At this time arrangements had been completed for the H. H. Franklin Co. of Syracuse, N. Y., to devote a large part of their energies to the production of Hispano-Suiza parts, and the Pierce-Arrow Motor Car Co. of Buffalo, N. Y., had undertaken the production of a large number of 300 H. P. motors, as a sublicensee.

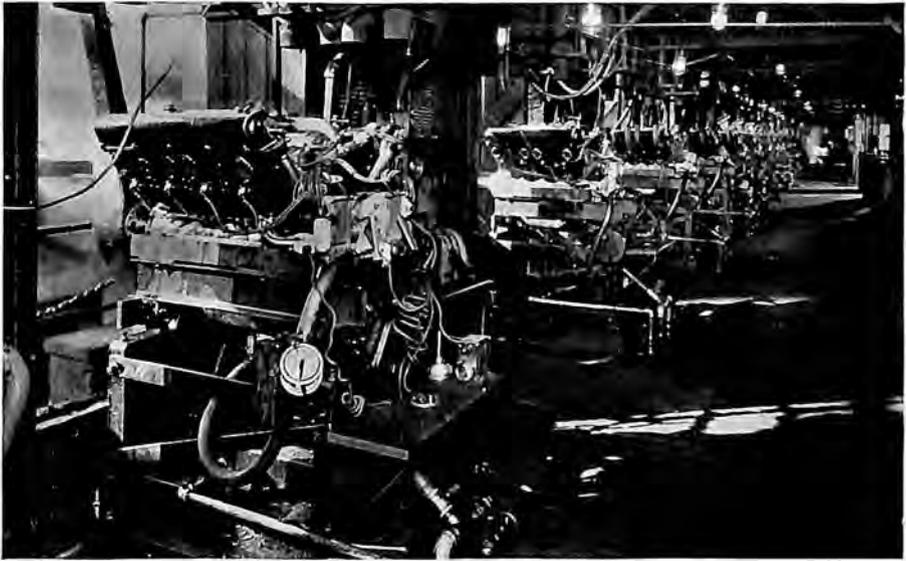
It has been mentioned that the 300 H. P. Hispano-Suiza motor



Finished Motors being Belted in. This is the finishing end of Assembling, the start of which is shown on page 276

would have been the Allies' principal fighting machine engine in 1919. The sample motors from the French factory made some extremely fine performances when tested in various planes by the French and British governments. The Wright-Martin model of the 300 Hispano on September 18, 1918, was used by Major R. W. Schroeder at Dayton, Ohio, in a flight which broke the then existing altitude record for a heavier-than-air flying machine, he reaching a height of 28,900 feet. Also, in the Spring of 1918 the Wright-Martin Corporation commissioned Mr. Grover C. Loening to build a couple of high-speed fighting airplanes suitable for the 300 H. P. motor and these, when tested just before the armistice, showed exceptional speed, rate of climb and, especially, ease of handling.

Other records to the credit of the Hispano-Suiza motor in America are a non-stop flight of 5 hours 48 minutes, covering 465 miles, made by Flight Commander Norman J. Boots of Selfridge Field, and the non-stop flight of the U. S. Navy dirigible C-1 from Rockaway Beach, N. Y., to Key West, Fla. Finally there is the trans-continental flight commenced December 4, 1918, by four Curtiss JN-4-H machines equipped with Hispano-Suiza motors, in command of Major A. D. Smith, from Rockwell Field, San Diego, Cal., to Mineola, Long Island, N. Y. Throughout this flight no forced landing had to be made due to motor trouble. The machines carried full



Testing the Finished Motors

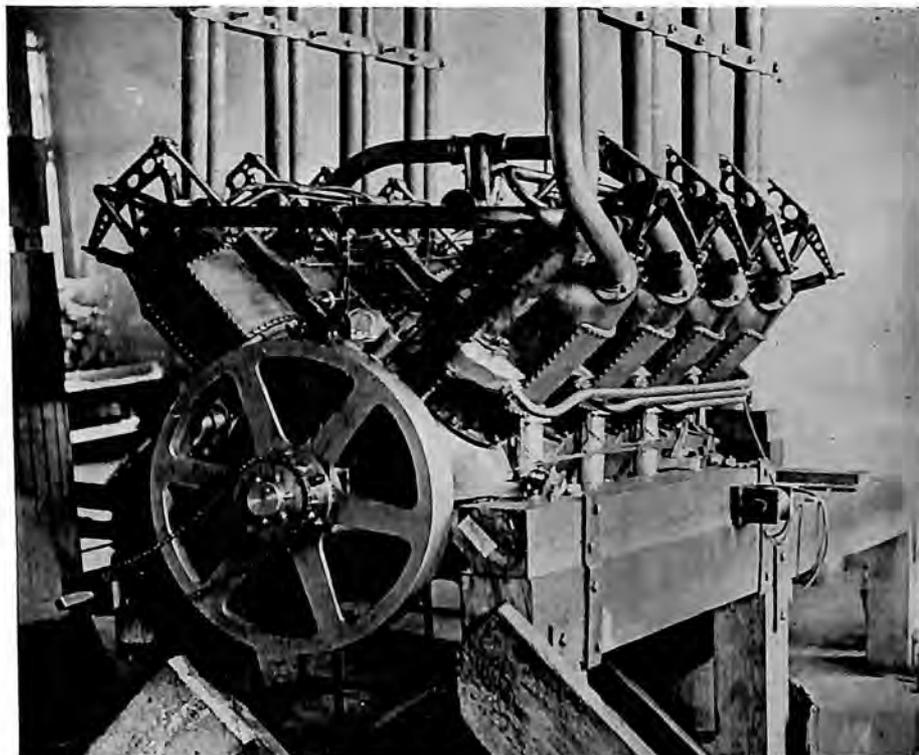
military loads, and often traversed country where for very long stretches no landing would have been possible.

The accomplishment of a company is impersonal, but it is made possible solely by the strength of the personalities contained within itself. No concern in America has done more towards winning the war in the air than the Wright-Martin Corporation, and few undertakings in aircraft manufacture have been more successful from a business viewpoint.

The leading personality which made possible this success is Mr. George H. Houston, who became vice-president and general manager on joining the company in May, 1917, and later became president.

Mr Houston had had some experience in aircraft production before taking charge of the Wright-Martin Corporation. Under his management the business of the corporation has grown from about \$200,000 per month to about \$4,000,000 in the short space of eighteen months.

Mr. W. F. McGuire, vice-president of George W. Goethals & Company, Inc., became vice-president of the Wright-Martin Corporation during 1918, and has exercised a general consulting supervision of the manufacturing in both the New Brunswick and Long Island City plants. His broad manufacturing experience has been of great importance in carrying on this work.

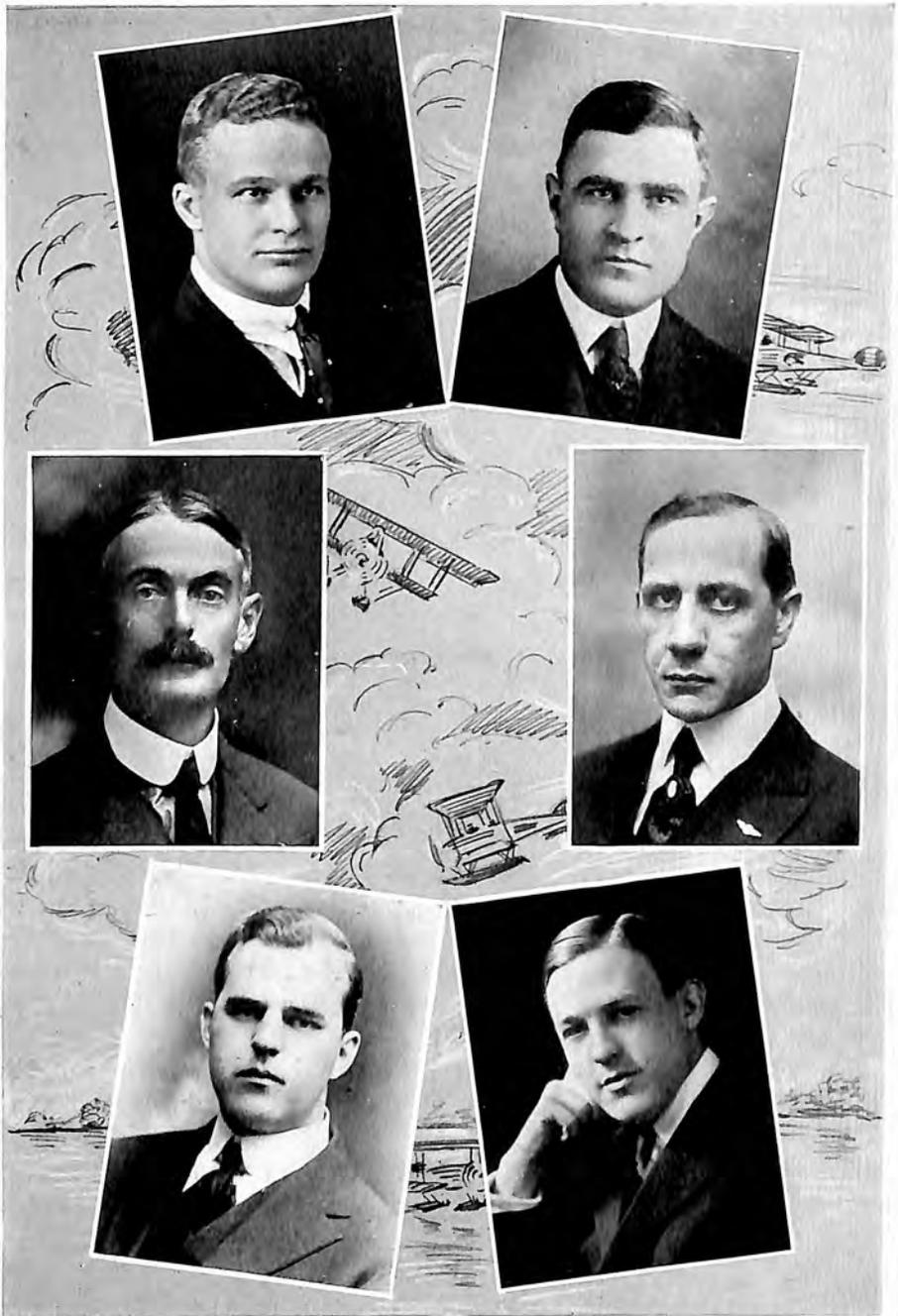


The Famous Dixie Boat Motor, Designed and Built by Mr. H. M. Crane in 1908. It won the Harmsworth Trophy against all European Challenging Boats

Mr. J. H. Anderson, vice-president in charge of finance and accounting, was elected to his present position June 1, 1918. On Mr. Anderson's shoulders has fallen the burden of systematizing the finance and accounting work of the Wright-Martin Corporation and this, in a concern which was growing at such an unprecedented rate, has been no light task.

Mr Henry M. Crane, vice-president and chief engineer of the Wright-Martin Corporation, was the man responsible for picking out the Hispano-Suiza engine when he visited France late in 1915. It was his judgment that brought this engine to the United States, and he has had full charge of its engineering development. He has introduced many improvements, bettering the performance and increasing the ease of manufacture.

His selection of the motor was of great value to the U. S. army, because, when it was wanted for practically the whole of the advanced training planes it was ready for delivery as fast as planes could be built and fields prepared.



WRIGHT-MARTIN EXECUTIVE OFFICERS

Top row, GUY W. VAUGHN, J. H. ANDERSON; center, HENRY M. CRANE, H. O. C. ISENBERG;
lower row, ALFRED WEILAND and RICHARD F. HOYT

In the work of developing the 300 H. P. Hispano motor he has been successful in producing an engine capable of delivering and sustaining the highest power in proportion to its weight of any water-cooled motor.

Mr. Richard F. Hoyt, joined the Wright-Martin Corporation as secretary and assistant to the president for the period of the war. His duties were naturally multifarious, and he was particularly well fitted for them by a long experience of banking, plus specialized early training in electrical and mechanical engineering.

Mr. William P. Anderson joined the corporation as assistant factory manager and proved his ability so quickly and thoroughly that in the fall of 1918 he took charge of all Wright-Martin manufacturing as general factory manager. He is an engineer of long and varied experience.

Mr. Alfred Weiland, production engineer has had charge of the development of the entire production program, since the Spring of 1917. His work consisted of determining the manufacturing methods to be used, deciding the facilities necessary for carrying out the methods and exercising a general supervision of the obtaining of equipment and its testing out and perfecting when obtained. No one has had a more direct responsibility in speeding up production.

Mr. H. O. C. Isenberg came to the Wright-Martin Corporation in December, 1917, as superintendent of assembly and testing. Being an experienced engineer, he quickly showed such a mastery of his work that he was made first assistant factory manager and later factory manager of the New Brunswick plant.

Mr. Guy W. Vaughn joined the corporation in the summer of 1917 and as quality manager has had all factory inspection under his control. The metallurgical laboratory and the heat treatment department upon which so much



B. A. Guy

depends are in his hands, and he also controls the service department which supervises Hispano-Suiza motors in the fields where they are used. His work has been of vital importance in these several directions. He is an engineer of long experience in automotive fields.

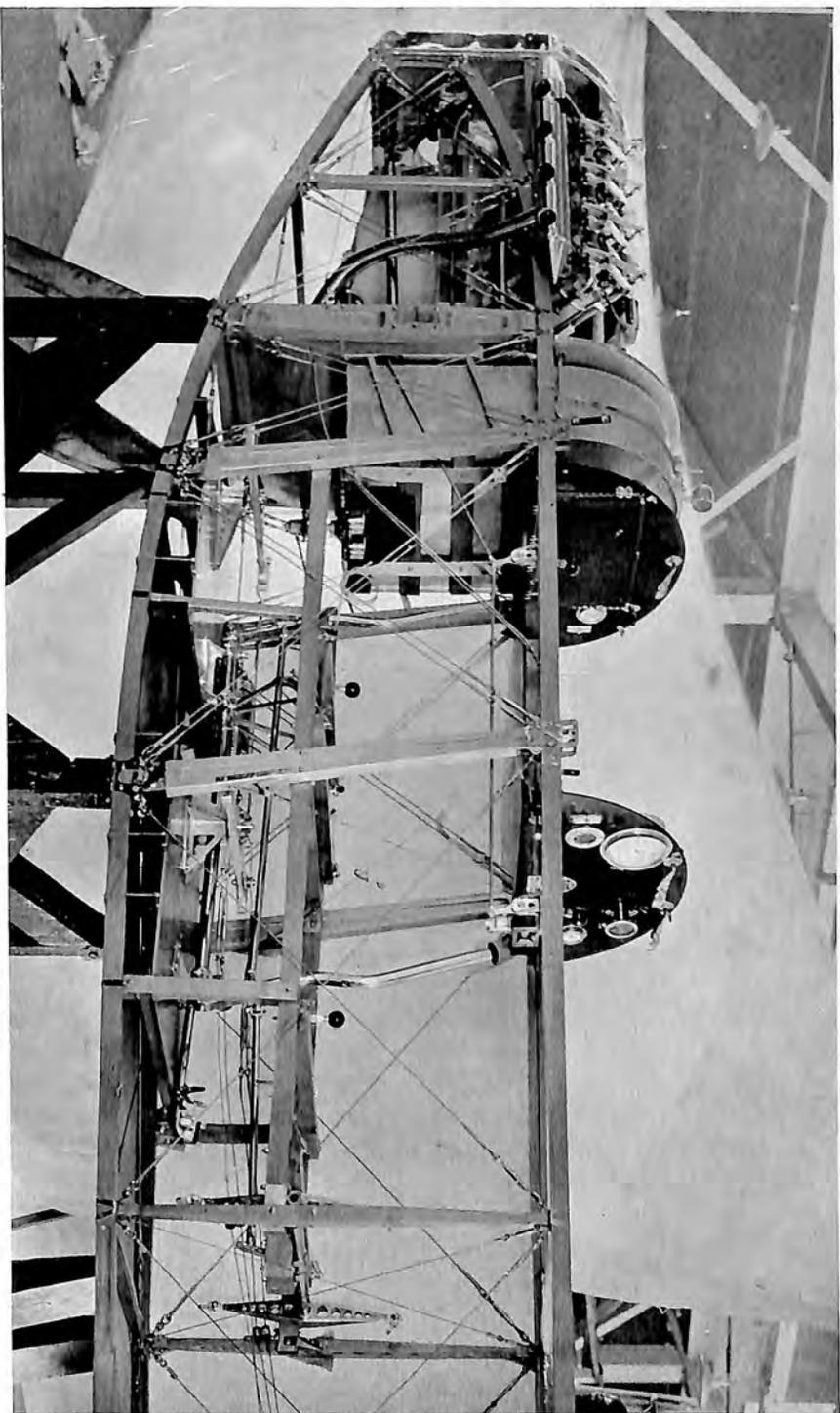
Mr. S. H. Humphreys had charge of first the New Brunswick plant and later the plant at Long Island City, giving particular attention to construction on each. The reconstruction of the New Brunswick plant was an arduous task since it had to be carried out without interference with production, and the arranging of the Long Island factory was no less difficult, owing to the extreme speed of action desired.

Mr. J. R. Cautley did valuable work for the corporation as its Washington representative, a position which he assumed in the fall of 1917 and held until after the end of the war. His duties were to keep in close touch with the requirements of both army and navy, and to give all the assistance he could to the War Department.

Mr. H. L. Pope was manager of an airplane factory at Los Angeles, Cal., which the Wright-Martin Corporation operated on a small scale in 1917 and finally closed. On completing his work there he went to England to supervise the installation of Wright-Martin engines in British S. E. 5 planes for the use of the American forces.

Mr. A. Ludlow Clayden was appointed consulting engineer in December, 1917, and immediately went to France, remaining there till near the end of the war. His duties were to watch the development of the French 300 H. P. motor and its applications to foreign planes while also studying manufacturing methods for the Hispano motor as practised abroad.

During the whole period of manufacture the War Department had representatives in constant association with all departments of the business and the Wright-Martin Corporation has derived much benefit from the earnest co-operation and the hearty goodwill which these officers have shown. They have been of great assistance in the successful carrying out of the corporation's undertakings.



A Stripped Fuselage, showing Standardized System of Controls for Training Machine



U. S. ARMY AVIATOR
(COMMISSIONED)



NAVAL AVIATOR
(COMMISSIONED)



U. S. ARMY OBSERVER



ENLISTED
MECHANICIAN



ENLISTED AVIATOR



ENLISTED MEN



GENERAL MACHINISTS' MATE



QUARTERMASTER



OFFICERS' COLLAR
INSIGNIA



AIRPLANE INSIGNIA
(ARMY AND NAVY)



COLLAR INSIGNIA
(ENLISTED MEN)

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D Building, 4½ Street and Missouri Avenue

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(Air Service, U. S. A.)	LIEUT. COMMANDER J. H. TOWERS
	(U. S. N.)

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AND OTHER AERIAL COMMITTEES

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(Johns Hopkins University)	(Director Bureau of Standards)
DR. E. D. ROSS	
(Bureau of Standards)	

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(E. R. C.)	

Bibliography of Aeronautics

PROF. CHARLES F. MARVIN, <i>Chairman</i>
(Chief U. S. Weather Bureau)
DR. JOSEPH S. AMES
(Johns Hopkins University)

Buildings, Laboratories and Equipment

DR. S. W. STRATTON	DR. JOSEPH S. AMES
DR. W. F. DURAND	LIEUT. COL. V. E. CLARK
	(U. S. A.)
COMMANDER J. H. TOWERS	
(U. S. N.)	

Civil Aerial Transport

DR. W. F. DURAND, <i>Chairman</i>	
DR. S. W. STRATTON	PROF. CHARLES F. MARVIN
(Bureau of Standards)	(U. S. Weather Bureau)
LIEUT. COL. V. E. CLARK	LIEUT. COMMANDER J. H. TOWERS
(Signal Corps, U. S. A.)	(U. S. N.)

Design, Construction, and Navigation of Aircraft

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THE WORLD'S ACES

THE American list is official to November 11, 1918, as is also the list of French Aces. The British, Italian, German, Russian and Turkish Aces are unofficial lists brought up to the summer of 1918.

AMERICAN ACES

Capt. Edward V. Rickenbacker, Columbus, Ohio	26	Major H. E. Hartney, Saskatoon, Canada	6
First Lieutenant Frank Luke, Jr. (killed in action), Phoenix, Ariz.	18	Captain Douglas Campbell, Mount Hamilton, Cal.	6
Major Victor Raoul Lufbery (killed in action) Wallingford, Conn.	17	Captain J. C. Vasconcelles, Denver, Col.	6
Capt. Reed G. Landis, Chicago, Ill.	12	Captain E. G. Tobin, San Antonio, Texas	6
First Lieutenant David E. Putnam (killed in action), Brookline, Mass.	12	First Lieutenant E. P. Curtis, Rochester, N. Y.	6
First Lieutenant Fields Kinley, Gravette, Ark.	10	First Lieutenant Sumner Sewell (no address), First Lieutenant R. A. O'Neill, Nogales, Ariz.	6
First Lieutenant G. A. Vaughn, Jr., 441 Washington Ave., Brooklyn	10	First Lieutenant Donald Hudson, Kansas City, Mo.	6
First Lieutenant J. M. Swaab, Philadelphia, First Lieutenant T. G. Cassady	10	First Lieutenant M. K. Guthrie, Mobile, Ala.	6
First Lieutenant C. E. Wright, Cambridge, Mass.	9	First Lieutenant W. H. Stovall, Stovall, Miss.	6
First Lieutenant W. P. Erwin, Chicago	9	First Lieutenant J. D. Beane (missing in action)	6
Captain E. W. Springs, Lancaster, Penn.	9	First Lieutenant A. R. Brooks, Framingham, Mass.	6
First Lieutenant H. R. Clay, Jr., Fort Worth, Texas	8	First Lieutenant R. O. Lindsay, Madison, N. C.	6
Major J. A. Meissner, 45 Lenox Road, Brooklyn, N. Y.	8	First Lieutenant Martinus Stenseth, Twin City, Minn.	6
Captain Hamilton Coolidge (deceased), Boston, Mass.	8	Second Lieutenant F. K. Hays, Chicago, Ill., First Lieutenant H. C. Klotts (no address)	6
Captain G. De F. Lerner, Washington, D. C., First Lieutenant P. F. Baer, Fort Wayne, Ind.	8	Lieutenant Colonel William Thaw, Pittsburgh, Penn.	5
First Lieutenant F. O. D. Hunter, Savannah, Ga.	8	Major D. McK. Peterson, Honesdale, Penn., Captain H. R. Buckley, Agawam, Mass.	5
First Lieutenant W. W. White, 541 Lexington Ave., New York City	8	Major C. J. Biddle, Philadelphia, Penn.	5
Second Lieutenant Clinton Jones, San Francisco, Cal.	8	First Lieutenant James Knowles, Cambridge, Mass.	5
Captain R. M. Chambers, Memphis, Tenn., First Lieutenant Harvey Cook, Toledo, Ohio, First Lieutenant L. C. Holden, 103 Park Ave., New York	7	First Lieutenant J. A. Healey, Jersey City, N. J.	5
First Lieutenant K. H. Schoen (deceased), Indianapolis, Ind.	7	First Lieutenant Innis Potter (no address)	5
First Lieutenant W. A. Robertson, Fort Smith, Ark.,	7	First Lieutenant F. M. Symonds, 20 West 8th St., New York City	5
First Lieutenant L. J. Rummell, 798 South 11th St., Newark, N. J.	7	First Lieutenant J. F. Wehner (deceased), 124 East 28th St., New York	5
First Lieutenant L. A. Hamilton (deceased) Burlington, Vt. or Pittsfield, Mass.	7	First Lieutenant J. J. Seerley, Chicago, Ill., First Lieutenant E. M. Haight, Astoria, N.Y.	5
First Lieutenant J. O. Creech, Washington, D. C.	6	First Lieutenant H. H. George, Niagara Falls, N. Y.	5
Second Lieutenant Howard Burdick, 175 Remsen St., Brooklyn, N. Y.	6	First Lieutenant G. W. Furlow, Rochester, Minn.	5
First Lieutenant C. L. Bissell, Kane, Penn.	6	First Lieutenant A. E. Easterbrook, Fort Flagler, Wash.	5
		First Lieutenant B. V. Baucom, Milford, Texas	5
		Second Lieutenant Harold McArthur (no address)	5
		Second Lieutenant J. S. Owens, Baltimore, Md.	5

BRITISH ACES

1—Major Wm. A. Bishop	72	46—Lieutenant W. G. Miggitt	5
2—Captain Jos. McCudden	54	47—Lieutenant Lawrence W. Allen	5
3—Captain Philip F. Fullard	48	48—Lieutenant Wm. D. Matheson	5
4—Captain Henry W. Wollett (13 in 1 day),	28	49—Lieutenant Stanley J. Coble	5
5—Lieutenant John J. Malone	20	50—Captain G. H. Boardman	5
6—Lieutenant Allan Wilkenson	19	51—Lieutenant F. T. S. Menendez	5
7—Lieutenant Stanley Rosevear	18	52—Captain K. C. Patrick	5
8—Lieutenant Robert A. Little	17	53—Sergeant T. F. Stephenson	5
9—Lieutenant Clive Warman	15	54—Commander F. C. Armstrong	Many
10—Lieutenant Fred Libby	14	55—Commander R. F. Minitie	Many
11—Captain W. C. Campbell	14	56—Commander E. L. N. Clarke	Many
12—Lieutenant R. T. C. Hoidge	14	57—Commander R. B. Munday	Many
13—Captain Murray Gilbraith	13	58—Commander G. W. Price	Many
14—Lieutenant Jos. Stewart Fall	13	59—Commander R. J. O. Compston	Many
15—Lieutenant A. K. Cowper	12	60—Lieutenant V. R. Stokes	Many
16—Captain Whitaker	12	61—Lieutenant W. C. Canbray	Many
17—Captain Robert Dodds	11	62—Lieutenant H. T. Beamish	Many
18—Lieutenant M. D. C. Scott	11	63—Lieutenant E. T. Hayen	Many
19—Lieutenant Raymond Collinshaw	10	64—Lieutenant G. W. Hemming	Many
20—Lieutenant R. A. Mayberry	9	65—Lieutenant J. E. L. Hunter	Many
21—Lieutenant John Andrews	9	66—Lieutenant W. A. Curtiss	Many
22—Captain Gilbert Ware Green	9	67—Captain H. T. Mellings (wounded May	
23—Lieutenant K. R. Park	9	18, 1918)	Many
24—Lieutenant M. B. Frew	8	68—Lieutenant Gerard B. Crole	Many
25—Sergeant Dean I. Lamb	8	69—Lieutenant Robert N. Hall	Many
26—Lieutenant Boyd Samuel Breadner	8	70—Lieutenant David Sidney Hall	Many
27—Lieutenant Andrew McKeever	8	71—Lieutenant M. J. G. Day	Many
28—Lieutenant J. H. T. Letts	8	72—Lieutenant E. G. Johnston	Many
29—Lieutenant Lionel B. Jones	7	73—Lieutenant W. L. Jordan	Many
30—Lieutenant A. S. Shepherd	7	74—Lieutenant M. H. Finley	Many
31—Lieutenant James Dennis Payne	7	75—Lieutenant C. B. Ridley	Many
32—Lieutenant G. E. H. McElroy	7		
33—Captain C. A. Brewster-Joske	7		
34—Captain Wagour	7		
35—Captain Frank G. Quigley . 6 (all in 1 day)			
36—Captain G. E. Thomson	6		
37—Captain Lancelot L. Richardson	6		
38—Lieutenant Cecil Roy Richards	6		
39—Lieutenant Howard Saint	6		
40—Lieutenant Fred John Gibbs	6		
41—Lieutenant C. W. Cudmore	6		
42—Lieutenant Wm. Lewis Wells	5		
43—Lieutenant E. D. Clarke	5		
44—Captain Fred Hope Lawrence	5		
45—Lieutenant Edward R. Grange	5		

BRITISH ACES—DEAD OR RETIRED

76—Captain Albert Ball	43
77—Captain Brunwin Hales	27
78—Captain Francis McCubbon	23
79—Captain George Thomson	21
80—Captain J. L. Trollope (6 in 1 day)	18
81—Lieutenant Leonard M. Barlow	17
82—Lieutenant Clive F. Collett	15
83—Captain H. G. Reeves	13
84—Captain Noel W. W. Webb	12
85—Lieutenant Rhys-David	9
86—Captain Henry G. Luchford	7

FRENCH ACES

1—Fonck	75	11—Haegelen	22
2—Guynemer (KA)	53	12—Marinovitch	21
3—Nungesser	43	13—Heurtaux	21
4—Madon	41	14—Deullin	20
5—Boyan (KA)	35	15—De Slade	19
6—Coiffard (KA)	34	16—Ehrlich (Disappeared)	19
7—Bowjade	28	17—De Romanet	18
8—Pinsard	27	18—Chaput (KA)	16
9—Guerin (KA)	23	19—De Turenne	15
10—Dorme	23	20—D'Argueff	15

FRENCH ACES—CON.

21—Sardier	14	36—Montrion (KA)	11
22—Ambrogi	14	37—Herisson	11
23—Garaud	13	38—Ortoli	11
24—Nogues	13	39—Berthelot	11
25—Demeuldre (KA)	13	40—Maunowry	11
26—Navarre	12	41—Nuville	11
27—Jailler	12	42—Bouyer	11
28—Hugues	12	43—Herbelin	10
29—Leps	12	44—Lahouille	10
30—Tarascon	12	45—Quette (KA)	10
31—Daladier	12	46—Waddington	10
32—De Sevin	12	47—Boon-Verduraz	10
33—Casale	12	48—Mace	10
34—Artigaut	12	49—Pezon	10
35—Guyon	12		

ITALIAN ACES

1—Major Baracca (killed, June 21, 1918)	36	8—Lieutenant Hanza	11
2—Lieutenant Barachini	31	9—Sergeant Maisero	8
3—Lieutenant Ancilotti	19	10—Lieutenant Parnis	7
4—Colonel Picco	17	11—Sergeant Poli	6
5—Captain Dude Calabria	16	12—Lieutenant Luigi Olivi	6
6—Lieutenant Scaroni	13	13—Lieutenant Stophanni	6
7—Lieutenant Olivari (killed)	21	14—Lieutenant Arrigoni	5

RUSSIAN ACES

1—Captain Kosakoff	17	3—Lieutenant Pachtchenko	5
2—Captain Kroutenn (killed, June 22, 1917)	6		

GERMAN ACES

1—Lieutenant Max Buckler	33	25—Lieutenant Schmidt	15
2—Captain Berthold	33	26—Lieutenant Hess	13
3—Lieutenant Menckhoff	33	27—Lieutenant Muller	13
4—Lieutenant Loerzer (wounded June 15 1918)	33	28—Lieutenant Goettsch	13
5—Lieutenant Schleich	30	29—Lieutenant Goering	10
6—Captain Brunowsky—Austria	29	30—Lieutenant Banfield—Austria	9
7—Lieutenant von Bulow	28	31—Sergeant Frickart	9
8—Lieutenant Kroll	28	32—Lieutenant von Althaus	8
9—Lieutenant Wuesthoff	27	33—Lieutenant Esswein	6
10—Lieutenant Udet	27	34—Lieutenant Walz	6
11—Lieutenant Lowenhardt	27	35—Lieutenant Hehn	6
12—Lieutenant Arigi—Austria	26	36—Lieutenant Koening	6
13—Lieutenant Peutter	25	37—Captain Zauder	5
14—Lieutenant Link Crawford—Austria	23	38—Lieutenant Brauneck	5
15—Captain Baumer	23	39—Lieutenant Ullmer	5
16—Lieutenant Kirstein	23	40—Lieutenant Roth	5
17—Corporal Rumej	23		
18—Lieutenant Klien	22	GERMAN ACES—DEAD OR RETIRED	
19—Lieutenant Windisch	21	41—Captain von Richthofen (killed, April 21, 1918)	80
20—Lieutenant Adam	21	42—Lieutenant Werner-Voss-Crefeld (killed, October 8, 1917)	49
21—Lieutenant Veltgens	21	43—Captain Boelke	40
22—Lieutenant Thuy	20	44—Lieutenant Gontermann (November 3, 1917)	39
23—Lieutenant Reinhardt	20		
24—Lieutenant Kissenberth	17		

GERMAN ACES—CON.

45—Lieutenant Max Muller (January 15, 1918)	38	65—Lieutenant Immelmann	15
46—Lieutenant Bongartz (wounded March 3, 1918)	36	66—Lieutenant Nathonnall	14
47—Lieutenant Curt Wolf	33	67—Lieutenant Dassenbach	14
48—Lieutenant Schaeffer	30	68—Lieutenant Fesnter	12
49—Lieutenant Almenroeder	30	69—Lieutenant Pfeiffer	12
50—Lieutenant von Richthofen (wounded)	29	70—Lieutenant Manschatt	12
51—Captain von Tutscheck (March 17, 1918)	27	71—Lieutenant Hohndorf (October 13, 1917)	12
52—Lieutenant Barnet (October 13, 1917) .	27	72—Lieutenant Mutschaat	12
53—Lieutenant Dosler (January 1, 1918) .	26	73—Lieutenant Buddecke	12
54—Lieutenant Erwin Boehm (December 1, 1917)	24	74—Lieutenant von Kendall	11
55—Lieutenant von Tschwibon (November 22, 1917)	20	75—Lieutenant Kirmaier	11
56—Lieutenant von Eschwege	20	76—Lieutenant Theiller	11
57—Lieutenant Bethge (March 17, 1918) . .	20	77—Lieutenant Herman Serfert	11
58—Captain Behr	19	78—Lieutenant Mulzer	10
59—Lieutenant Thulzer	19	79—Lieutenant Lessers	9
60—Lieutenant Baldamus	18	80—Lieutenant Schulte	9
61—Lieutenant Wintgens	18	81—Lieutenant Parschau	8
62—Lieutenant Frankel	17	82—Lieutenant Schilling	8
63—Lieutenant Geigel (May 13, 1918) . . .	15	83—Lieutenant Immelmann	6
64—Lieutenant Schneider	15	84—Lieutenant Fahlbausch	5
		85—Lieutenant von Siedlitz	5
		86—Lieutenant Rosenkranz	5
		87—Lieutenant Harbor	5
		88—Lieutenant Reimann	5

TURKISH ACE

1—Captain Schetz	8
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THE BEGINNING OF PRACTICAL AVIATION

IN 1887, a professor of mathematics and astronomy, attached to the Smithsonian Institution in Washington, began a series of experiments touching "mechanical flight." His action was somewhat undignified, unprofessional. "The whole subject of mechanical flight," he confesses later, "was generally considered to be a field fitted rather for the pursuits of the charlatan than for those of the man of science." And Samuel Pierpont Langley was a man of science. Nevertheless, he took the matter up. He gave this disreputable field of inquiry the decent and scientific name of "aerodynamics." He laid for it scientific foundations, the first of which were incorporated in "Experiments in Aerodynamics," a Smithsonian publication of 1891. Eventually he was to prove with small models the possibility of the flight of heavier-than-air machines, though two accidents were to defraud him of a success which his man-carrying "aerodrome" was capable of achieving.

Langley was, of course, not the first student of flight; such men as Sir George Cayley (1809), Henson (1842) and Stringfellow (1846) in England and D'Amecourt (1862) and Ader (1890) in France, had got interesting results from a problem, which had fascinated men from the early Greeks downward. But Langley was the first worker in the particular movement which was to end in practical flying. He was of the company of Maxim, Lilienthal, Chanute and Hargrave. He was to be followed by the Wrights, Bleriot, Curtiss, Nieuport and Fokker.

Langley's contribution to the science of flying was varied and fundamental. He worked at the problem from the standpoint of physics, building a "whirling table" by which he recorded pressures, resistances, lifting and driving powers of surfaces. He shaped wings, propellers, etc., in the course of these experiments, discovering what were the best shapes for such surfaces. He studied the problem of equilibrium and eventually developed models with wing spreads of ten to fourteen feet. He built small steam engines which would propel these models. On May 6, 1896, one of his models flew for over half a mile above the Potomac River, descended unhurt, and made a second flight the same day.

The man-carrying "aerodrome" which Langley eventually completed in the fall of 1903, was twice wrecked in launching, and the general impression existed that it was a failure. Subsequent

experiment proved the falsity of this, for the machine, which in one case was wrecked by a lug on the track from which it was started, and in the other, probably, by the tail surfaces being broken on the track, was flown successfully over Lake Keuka in 1915 by Glenn H. Curtiss without alteration in the design of the machine or the power plant, and with the addition of pontoons as an undercarriage which outweighed the original chassis used by Langley and Manly.

Langley's experiments with airplane models had suggested the essentials of the modern machine with the exception of the undercarriage and an adequate controlling system. The latter was under his consideration, and some measure of control and a great deal of automatic stability had been attained. He was very close to successfully directed flight, closer than Hiram Maxim in England. Maxim had begun experiments in 1888. He had proceeded on the theory that an airplane could be built by theory and harnessed to a track while men learned to fly it. He contrived a remarkable machine, developing with its 5,400 square feet of supporting surface a 10,000 pound lift against a total weight of 7,000 pounds. He devised a steam engine which delivered 360 H. P. But the machine would not be held while men learned to direct it. It tore loose from its track one gusty day and was wrecked. And there was no second \$100,000 available with which to duplicate it.

Meanwhile a retired German factory owner named Otto Lilienthal had begun carrying out experiments for which long mechanical study and practice had fitted him. He had no patience with monstrous schemes like Maxim's. He realized that before a machine could fly it must have an experienced pilot. "To contrive is nothing, to construct is something, to operate is everything," he said. And he began to operate at once. As early as 1891 he succeeded in managing gliders, and he gradually increased the lifting capacity and the stability of his machines until he was "king of the air in calm weather."

But Lilienthal valued practice too much and design too little. He employed a rudder for direction and for longitudinal control, but for lateral control he had nothing more scientific to offer than a change in the position of his legs. And his legs were insufficient. In August, 1896, when he was contemplating the installation of a power plant in a new glider, the inefficiency of his primitive lateral control allowed him to be overturned in flight by a gust of wind. He fell fifty feet and was killed. If he had lived he might have made headway with the problem of control. He wrote in April, 1896, that

he was "engaged in constructing an apparatus in which the position of the wings can be changed during flight in such a way that the balancing is not effected by changing the position of the center of gravity of the body."

Lilienthal's death did not rob the world of experimenters in gliding. Percy S. Pilcher was carrying on flights in England, successful, but soon to end fatally, and in the United States, Octave Chanute and A. M. Herring were carrying on tests (similar to Lilienthal's) near Chicago, where the dunes of Lake Michigan were favorable to gliding. Chanute worked with multiplanes, using as many as five superimposed surfaces, but, finally, developed a biplane type, which was widely copied by designers of biplanes. But even Chanute did not solve the problem of control, though he improved on Lilienthal's achievement. The best he could do was to effect with a two-inch shift of the body what Lilienthal could accomplish only with a five-inch shift.

When the report of Lilienthal's death reached the United States, it was read by two brothers living in Dayton, Ohio; Wilbur and Orville Wright. They had always been interested in flying since their father had surprised them in 1878 with a toy helicopter, a type of airplane which projects itself directly upward. The Wright brothers as boys were great builders of kites. And when they had established themselves in business, they began to be interested in the problem of mechanical flight. They read Chanute's *Progress of Flying Machines*, Langley's *Experiments*, articles by Lilienthal and Mouillard's *Empire of the Air*. They were interested in flying as a sport, and they were drawn to the Lilienthal-Pilcher-Chanute type of experimentation partly because it seemed to be great fun, and partly because they thought a flyer should learn to fly before he trusted himself to a powered machine. Still, they learned much from Langley, as they testify.

Lilienthal's legs may probably claim the distinction of being more responsible for the development of flying than Lilienthal's brain. They set the Wrights thinking upon the problem of stability. The two brothers saw that the German's contortions in mid-air offered an insufficient control, for "the weight to be moved and the distance of possible motion were limited;" whereas the wind forces, which they were supposed to combat, were capable of developing, in conjunction with the wings of the machine, into something comparatively unlimited. "We would arrange the machine," the Wrights decided, "so that it would right itself."

This was the chief object of the experiments at Kitty Hawk, N. C., which, as the world knows, eventually led to flight. Work began in 1900 with gliders flown as kites. Chanute visited the little station and offered suggestions. In their experiments the Wrights found themselves obliged to turn from sportsmen to scientists. They built a "wind tunnel" for determining the behavior of surfaces,—a tunnel sixteen inches in diameter through which a blast was driven by a mechanically operated fan. Eventually they worked out a machine with a rudder for directional control, an elevator set in front for longitudinal control, and a system of warping the wings to change their angle with relation to the path of flight to insure lateral control. This latter development was probably the most important single contribution which they made to practical flying. It was used by them in connection with the directional rudder in making turns, and though the effect of warping is now gained by the use of ailerons, the service rendered by the Wright invention has been a highly valuable one.

The story of the first flight, made December 17, 1903, at Kitty Hawk, N. C., is told by Mr. Orville Wright himself in an article which follows this. It was really the first sustained and controlled power-driven flight made in the world.

The first really public European flights seem to have been made by Santos-Dumont in September, and in November of 1906. The Wrights, meanwhile, satisfied with what they could do, were biding their time till the matter of patents could be satisfactorily settled. They had flown frequently near Dayton during 1904 and 1905, and on September 26, 1905 had made a flight of eleven miles, but their achievement had not been exhibitionary. Henri Farman was beginning to fly in France in the fall of 1907, and in America the Aerial Experiment Association was doing interesting things. Dr. Alexander Graham Bell, Lieutenant T. Selfridge, F. W. Baldwin, J. A. D. McCurdy, and Glenn H. Curtiss were associated in this enterprise, Mrs. Bell furnishing money and Curtiss the motors. On March 12, 1908, the "Red Wing," the Association's first machine, flew 319 feet, rising from and landing on the ice of Lake Keuka near Hammondsport, New York. The "White Wing," the second, flew 1,017 feet, and the "June Bug," the third piloted by Mr. Curtiss, won the *Scientific American* prize for the first public flight of one kilometer made July 4, 1908.

The Wrights now returned to flying, and on September 9, 1908, Orville Wright made two voyages approximately an hour each. On October 20th and 21st of the same year, Bleriot and Farman in France made cross-country flights of about seventeen miles each.

And from now on the success of flying was only a matter of time.

The development traced so far has been that of heavier-than-air machines built to fly over land or ice. The birth and development of seaplanes has not been noticed. The progress made in flying over water was slower than that in soaring above the land, although Langley had realized that water was preferable to land in case of a fall, and had carried on all his experiments over the Potomac. In 1908, the Aerial Experiment Association had attached pontoons to the "June Bug," but the engine could not drive the machine faster than twenty-five miles an hour, too slow for rising from water. Mr. Glenn H. Curtiss, however, carried on experiments with pontoons at North Island, near San Diego, Cal., and developed there a satisfactory hydro-aeroplane. Here also he developed the flying boat, the boat acting as a fuselage and under-carriage in one.

Meanwhile, there had been noteworthy developments in airplane designs. In 1908, the machines generally flown had much about them needing improvement. The Wright and Curtiss machines used elevators set in front of the pilot and the wings. The Wrights had not yet adopted the wheels of the modern undercarriage; Curtiss set his ailerons between the planes or wings. No machine was using an enclosed body; the pilot was exposed to the rush of air, and engines, wires, ribs of wings, etc., were bared and offered tremendous resistance. Bleriot and Nieuport were to prove the advantage of a body—streamlined to cut the air with minimum resistance—over the outrigging on which the rudders of the earlier machines had been set. Gradually the modern type was to evolve ailerons set in the wing tips for lateral control and to reduce resistance, rudder and elevators both to the rear, and a fuselage or enclosing body carrying engine and pilot, and cutting down resistance by its streamline shape. The war has carried this general type to a high point of efficiency. Powerful motors (the Wrights used a 20 H. P. in 1903, and the well-known Liberty develops 400), scientific application of streamlining—lessening shapes to all elements from wires to tail skid, the development of aluminum for engines, the improvement in propellers, the discovery of wing shapes peculiarly fitted to develop lifting capacity—these are in general the noteworthy elements in the progress of flight. Great speed, experiments with material and methods of testing their strength, and thorough training of pilots have made for safety. Accidents have become comparatively rare, and are now scarcely above the average for vigorous sport of any kind. The airplane is already the automobile of the air, and promises to be railroad and steamship as well.



HOW WE MADE THE FIRST FLIGHT*

BY ORVILLE WRIGHT

THE flights of the 1902 glider had demonstrated the efficiency of our system of maintaining equilibrium, and also the accuracy of the laboratory work upon which the design of the glider was based. We then felt that we were prepared to calculate in advance the performance of machines with a degree of accuracy that had never been possible with the data and tables possessed by our predecessors. Before leaving camp in 1902 we were already at work on the general design of a new machine which we proposed to propel with a motor.

We decided to undertake the building of the motor ourselves. We estimated that we could make one of four cylinders with 4-inch bore and 4-inch stroke, weighing not over 200 pounds, including all accessories. The ability to do this quickly was largely due to the enthusiastic and efficient services of Mr. C. E. Taylor, who did all the machine work in our shop for the first as well as for the succeeding experimental machines.

While Mr. Taylor was engaged with this work, Wilbur and I were busy in completing the design of the machine itself. The preliminary tests of the motor having convinced us that more than 8 horse power would be secured, we felt free to add enough weight to build

*From an article in December, 1913, issue of *Flying*.

a more substantial machine than we had originally contemplated.

When the motor was completed and tested we found that it would develop 16 horse power for a few seconds, but that the power rapidly dropped till, at the end of a minute, it was only 12 horse power. Ignorant of what a motor of this size ought to develop, we were greatly pleased with its performance. More experience showed us that we did not get one-half of the power we should have had.

With 12 horse power at our command, we considered that we could permit the weight of the machine with operator to rise to 750 or 800 pounds and still have as much surplus power as we had originally allowed for in the first estimate of 550 pounds.

We left Dayton, September 23d, and arrived at our camp at Kill Devil Hill on Friday, the 25th. We found there provisions and tools, which had been shipped by freight several weeks in advance. The building, erected in 1901 and enlarged in 1902, was found to have been blown by a storm from its foundation posts a few months previously. While we were waiting the arrival of machinery and parts from Dayton, we were busy putting the old building in repair, and erecting a new building to serve as a workshop for assembling and housing the new machine.

Just as the building was being completed, the parts and material for the machines arrived simultaneously with one of the worst storms that had visited Kitty Hawk in years. The storm came on suddenly, blowing 30 to 40 miles an hour. It increased during the night, and the next day was blowing over 75 miles an hour. In order to save the tar-paper roof, we decided it would be necessary to get out in this wind and nail down more securely certain parts that were especially exposed. When I ascended the ladder and reached the edge of the roof, the wind caught under my large coat, blew it up around my head and bound my arms till I was perfectly helpless. Wilbur came to my assistance and held down my coat while I tried to drive the nails. But the wind was so strong I could not guide the hammer and succeeded in striking my fingers as often as the nails.

The first run of the motor on the machine developed a flaw in one of the propeller shafts which had not been discovered in the test in Dayton. The shafts were sent at once to Dayton for repair, and were not received again until November 20, having been gone two weeks. We immediately put them in the machine and made another test. A new trouble developed. The sprockets, which were screwed on the shafts and locked with nuts of opposite thread, persisted in coming loose. After many futile attempts to get them fast,

we had to give up for that day, and went to bed much discouraged. However, after a night's rest, we got up the next morning in better spirits and resolved to try again.

While in the bicycle business we had become well acquainted with the use of hard tire cement for fastening tires on the rims. We had once used it successfully in repairing a stop watch after several watch-smiths had told us it could not be repaired. If tire cement was good for fastening the hands on a stop watch, why should it not be good for fastening the sprockets on the propeller shaft of a flying machine? We decided to try it. We heated the shafts and sprockets, melted cement into the threads and screwed them together again. This trouble was over. The sprockets stayed fast.

On November 28th, while giving the motor a run indoors, we thought we again saw something wrong with one of the propeller shafts. On stopping the motor we discovered that one of the tubular shafts had cracked!

Immediate preparation was made for returning to Dayton to build another set of shafts. We decided to abandon the use of tubes, as they did not afford enough spring to take up the shocks of premature or missed explosions of the motor. Solid tool-steel shafts, of smaller diameter than the tubes previously used were decided upon. These would allow a certain amount of spring. The tubular shafts were many times stronger than would have been necessary to transmit the power of our motor, if the strains upon them had been uniform. But the large hollow shafts had no spring in them to absorb the unequal strains.

Wilbur remained in camp while I went to get the new shafts. I did not get back to camp again till Friday, the 11th of December. Saturday afternoon the machine was again ready for trial, but the wind was so light a start could not have been made from level ground with the run of only sixty feet permitted by our monorail track. Nor was there enough time before dark to take the machine to one of the hills where, by placing the track on a steep incline, sufficient speed could be secured for starting in calm air.

Monday, December 14th, was a beautiful day, but there was not enough wind to enable a start to be made from the level ground about camp. We therefore decided to attempt a flight from the side of the big Kill Devil Hill. We had arranged with the members of the Kill Devil Life Saving Station, which was located a little over a mile from our camp, to inform them when we were ready to make the first trial of the machine. We were soon joined by J. T. Daniels,

Robert Westcott, Thomas Beachem, W. S. Dough and Uncle Benny O'Neal of the Station, who helped us get the machine to the hill, a quarter mile away. We laid the track 150 feet up the side of the hill on a 9-degree slope. With the slope of the track, the thrust of the propellers and the machine starting directly into the wind, we did not anticipate any trouble in getting up flying speed on the 60-foot monorail track. But we did not feel certain that the operator could keep the machine balanced on the track.

When the machine had been fastened with a wire to the track, so that it could not start until released by the operator, and the motor had been run to make sure that it was in condition, we tossed up a coin to decide who should have the first trial. Wilbur won. I took a position at one of the wings, intending to help balance the machine as it ran down the track. But when the restraining wire was slipped, the machine started off so quickly I could stay with it only a few feet. After a 35- to 40-foot run it lifted from the rail. But it was allowed to turn up too much. It climbed a few feet, stalled, and then settled to the ground near the foot of the hill, 105 feet below. My stop watch showed that it had been in the air just $3\frac{1}{2}$ seconds. In landing, the left wing touched first. The machine swung around, dug the skids into the sand and broke one of them. Several other parts were also broken, but the damage to the machine was not serious. While the test had shown nothing as to whether the power of the motor was sufficient to keep the machine up, since the landing was made many feet below the starting point, the experiment had demonstrated that the method adopted for launching the machine was a safe and practical one. On the whole, we were much pleased.

Two days were consumed in making repairs, and the machine was not ready again till late in the afternoon of the 16th. During the night of December 16, 1903, a strong, cold wind blew from the north. When we arose on the morning of the 17th the puddles of water, which had been standing about camp since the recent rains, were covered with ice. The wind had a velocity of 10 to 12 meters per second (22 to 27 miles an hour). We thought it would die down before long and so remained indoors the early part of the morning. But, when ten o'clock arrived, and the wind was as brisk as ever, we decided that we had better get the machine out and attempt a flight. We hung out the signal for the men of the life saving station. We thought that by facing the flyer into a strong wind there ought to be no trouble in launching it from the level ground about camp. We realized the difficulties of flying in so high a wind, but estimated

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that the added dangers in flight would be partly compensated for by the slower speed in landing.

We laid the track on a smooth stretch of ground about 100 feet north of the new building. The biting cold wind made work difficult, and we had to warm up frequently in our living room, where we had a good fire in an improvised stove made of a large carbide can. By the time all was ready, J. T. Daniels, W. S. Dough and A. D. Etheridge, members of the Kill Devil Life Saving Station, W. C. Brinkley, of Manteo, and Johnny Moore, a boy from Nag's Head, had arrived.

Wilbur, having used his turn in the unsuccessful attempt on the 14th, the right to the first trial now belonged to me. After running the motor a few minutes to heat it up, I released the wire that held the machine to the track, and the machine started forward into the wind. Wilbur ran at the side of the machine, holding the wing to balance it on the track. Unlike the start on the 14th, made in a calm, the machine, facing a 27-mile wind, started very slowly. Wilbur was able to stay with it till it lifted from the track after a forty-foot run. One of the life saving men snapped the camera for us, taking a picture just as the machine had reached the end of the track and had risen to a height of about two feet. The slow forward speed of the machine over the ground is clearly shown in the picture by Wilbur's attitude. He stayed along beside the machine without any effort.

The course of the flight up and down was exceedingly erratic, partly due to the irregularity of the air, and partly to lack of experience in handling this machine. The control of the front rudder was difficult on account of its being balanced too near the center. This gave it a tendency to turn itself when started, so that it turned too far on one side and then too far on the other. As a result, the machine would rise suddenly to about ten feet and then as suddenly dart for the ground. A sudden dart when a little over a hundred feet from the end of the track or a little over 120 feet from the point at which it rose into the air, ended the flight. As the velocity of the wind was over 35 feet per second and the speed of the machine over the ground against this wind ten feet per second, the speed of the machine relative to the air was over 45 feet per second, and the length of the flight was equivalent to a flight of 540 feet made in calm air. This flight lasted only 12 seconds, but it was nevertheless the first in the history of the world in which a machine carrying a man had raised itself by its own power into the air in full flight, had sailed forward without reduction of speed, and had finally landed at a point as high as that from which it started.

At twenty minutes after eleven Wilbur started on the second flight. The course of this flight was much like that of the first, very much up and down. The speed over the ground was somewhat faster than that of the first flight, due to the lesser wind. The duration of the flight was less than a second longer than the first, but the distance covered was about 75 feet greater.

Twenty minutes later the third flight started. This one was steadier than the first one an hour before. I was proceeding along pretty well when a sudden gust from the right lifted the machine up twelve to fifteen feet and turned it up sidewise in an alarming manner. It began a lively sliding off to the left. I warped the wings to try to recover the lateral balance, and at the same time pointed the machine down to reach the ground as quickly as possible. The lateral control was more effective than I had imagined, and before I reached the ground the right wing was lower than the left and struck first. The time of this flight was fifteen seconds and the distance over the ground a little over 200 feet.

Wilbur started the fourth and last flight at just 12 o'clock. The first few hundred feet were up and down as before, but by the time 300 feet had been covered, the machine was under much better control. The course for the next four or five hundred feet had but little undulation. However, when out about 800 feet the machine began pitching again, and in one of its starts downward struck the ground. The distance over the ground was measured and found to be 852 feet; the time of the flight, 59 seconds. The frame supporting the front rudder was badly broken, but the main part of the machine was not injured at all. We estimated that the machine could be put in condition for flight again in a day or two.

While we were standing about discussing this last flight, a sudden strong gust of wind struck the machine and began to turn it over. Everybody made a rush for it. Wilbur, who was at one end, seized it in front, Mr. Daniels and I, who were behind, tried to stop it behind, tried to stop it by holding to the rear uprights. All our efforts were vain. The machine rolled over and over. Daniels, who had retained his grip, was carried along with it, and was thrown head-over-heels inside of the machine. Fortunately he was not seriously injured, though badly bruised in falling about against the motor, chain guides, etc. The ribs in the surfaces of the machine were broken, the motor injured and the chain guides badly bent, so that all possibility of further flights with it for that year were at an end.

IMPORTANT EVENTS IN THE HISTORY OF HEAVIER-THAN-AIR FLYING MACHINES

- Circa 1500—Jean-Baptiste Dante, toward end of 15th Century, made flights with a glider near Lake Trasimene and in city of Perugia. Agency: non-vibrant wings.
- 1500—Leonardo Da Vince sketched a parachute, an ornithopter and a helicopter.
- 1676-'77—Besnier suggested an apparatus consisting of two rods, pivoted on the shoulder and equipped with fore and aft collapsible surfaces (like a book opening downward). Each up-stroke closed the surfaces and each down-stroke opened the surfaces for sustentation. Oscillating motion effected by action of hands and feet. Successful flight claimed.
- 1742—Marquis de Bacqueville, using imitation flapping wings, flew from his house on the Seine to Garden of Tuileries. Accident amidstream caused descent (wings ceased to act).
- 1781—Karl Meerwein, at Baden, computed the area of a spindle-shaped, man-supporting surface, from proportions of bird weight and wing surface. These figures were later substantiated by Lillienthal. Aviator was fastened to the middle of the under surface, holding a rod which operated the wings. One attempt by Meerwein was unsuccessful.
- 1809—Sir George Cayley built a glider of 300 foot wing surface, which skimmed the ground and sailed from hilltops, etc.
- 1842—Henson patented a monoplane to be driven by a steam engine. Wing span, 140 feet.
- 1855—Capt. LeBris made a partially successful flight with his glider.
- 1865-'67—Francis Wenham showed that the lifting power of one plane of large area could be obtained by dividing the large plane into several smaller planes arranged in tiers; hence Wenham's type with six superposed planes.
- 1871—M. A. Penaud built a toy model which flew 131 feet in the Garden of the Tuileries.
- 1874—D. S. Brown presented before the Aeronautical Society of Great Britain a memoire on an aeroplane with tandem planes. A stabilizing tail unit was included in the design.
- 1876—Penaud, in collaboration with Gauchot, published designs of an aeroplane with two propellers.
- 1877—Wm. Kress made a model fitted with two propellers and double control.
- 1879—Satin experimented with a model at Chalais-Mendon; model equipped with compressed air motor, actuating two propellers placed ahead of panels.
- 1886—Col. Renard presented to the Societe des Amis des Sciences, a paper on the principles of aerial navigation.
- 1889—(a) Renard exhibited a model in the Exposition at Paris. Followed Wenham's principle of six superposed planes.
(b) Lillienthal published his paper, "Bird Flight as a Basis for the Art of Flying."
- 1890—Satin commenced his experiments with a model aeroplane.
- 1890—October 9. Clement Ader, near Gretz, France, experimented with a monoplane driven by a 40 H. P. motor.
- 1891—Langley published his memoir, "Experiments in Aerodynamics," the result of researches on the resistance of planes.
- 1891—Lillienthal began experimental flights with monoplane gliders near Berlin.

- 1893—Horatio Phillips constructed a multiplane aeroplane, with wings superposed, after the principle of Wenham. Equipped with a 5.5 H. P. motor and one propeller.
- 1894—Sir Hiram Maxim built a three-man carrying machine; was a multiplane of 104 feet span, 4,000 feet supporting surface. Propellers operated by a 360 H. P. steam engine which weighed 11 pounds per horse power. Total weight, 8,000 pounds. Machine left the supporting track in final test and was wrecked.
- 1895—Percy S. Pilcher built monoplane gliders which operated successfully.
- 1896—May 6. Prof. S. P. Langley's steam-driven toy monoplane model flew over the Potomac successfully for over 3,000 feet, at from 20 to 25 miles per hour.
- 1896—June 22. Octave Chanute, assisted by A. M. Herring and Avery, made experimental flights on sand dunes near Lake Michigan. They developed Chanute's multiple glider and the Chanute biplane glider.
- 1896—August 9. Lillienthal flew a biplane glider previous to fitting it with a $2\frac{1}{2}$ H. P. engine. Operating principle was to continually shift weight of aviator so that center of gravity and center of pressure fell on the same vertical line. On the second flight he was killed.
- 1897—October 12. At Sartory, France, Clement Ader experimented with a machine equipped with 270 square feet of supporting surface. Weight, 1,100 pounds. Twin propellers, driven by a 40 H. P. steam engine, which weighed seven pounds per horse power.
- 1897—October 14—Ader's experiments continued. Machine wrecked on account of high wind.
- 1899—September 3. Percy S. Pilcher killed while gliding in gusty weather.
- 1900—Wilbur and Orville Wright experimented with gliders with arched surfaces and adjustable rudder in front. Flyer lay prone on upper surface of lower wing. Skids used for landing. Glider hovered in air for periods over a minute, and glided over 600 feet. Velocity of 20 miles per hour necessary for sustentation.
- 1903—December 17. **Wright Bros. fitted a biplane glider with a 16 H. P. motor, driving double screws behind the planes. Total weight of machine, 750 pounds. Flew at speed of 30-35 miles per hour for a period of twelve seconds. Tests made on the Kill-Devil dunes, N. C., ultimately sustained flight for a period of 59 seconds, covering 852 feet. First successful sustained flight in the world.**
- 1904—Autumn. Wright Bros made flights in a circle.
- 1905—October 5. Wright Bros flew for a distance of 24 miles in 38 minutes.
- 1906—September 13. Santos Dumont made the first officially recorded European aeroplane flight, leaving the ground for a distance of 36 feet, flying at a velocity of 23 miles per hour, used a cellular aeroplane, resembling a Hargrave kite; equipped with a 40-50 H. P. motor. Two wheels fitted to machine to permit "taking off" and landing.
- 1906—Santos Dumont remained in air for twenty-one seconds, and travelled a distance of 700 feet, winning several prizes offered by the French Aero Club.
- 1907—March 30. Delagrangé demonstrated a Voisin biplane.
- 1907—October 26. Henry Farman (an Englishman) flew a Voisin over 2,500 feet in 52.5 seconds, in a straight line.
- 1908—February 11. Henry Farman made a complete circuit of about a mile, in one and one-half minutes.

- 1908—June 22. Delagrangé flew in Milan, in a Voisin machine, covering a distance of $10\frac{1}{2}$ miles in sixteen minutes.
- 1908—July 4. Glenn H. Curtiss won the *Scientific American* trophy with the "June Bug," built by the Aerial Experiment Association, to the design of G. H. Curtiss. Machine weighed 650 pounds and had 370 square feet of supporting surface. Made 39 miles per hour. First previously announced flight in public.
- 1908—Henry Farman remained in air for 21.5 minutes, flying $\frac{3}{4}$ mile, and carrying a passenger.
- 1908—August 8. Orville Wright made official flights at the Camp of Auvours, surpassing French records for duration, distance and height of flights.
- 1908—September 9. Orville Wright made flight of one hour's duration.
- 1908—September 21. Orville Wright made flight of 1 hour 31 minutes' duration, covering 42 miles.
- 1908—October 10. Orville Wright made flight of 1 hour's duration, with passenger.
- 1908—October 31. Farman made first cross-country flight from Chalons to Rheims, a distance of 16 miles, in 20 minutes. Rose 200 feet from course to clear obstacles.
- 1908—End of year. First great Aeronautical Salon held in Paris. Over a dozen full-sized machines exhibited.
- 1908—Lectures on Aeronautics commenced at Göttingen University.
- 1908—December 31. Orville Wright made flight of two hours 19 minutes' duration, with passenger.
- 1909—Capt. Spelterini, Italian officer, explored the Alps in neighborhood of Mt. Blanc.
- 1909—British government appointed a permanent Aeronautical Committee; also a special department on Aeronautics, at the National Physical Laboratory at Leddington.
- 1909—July 19. Latham in a trial flight over the Channel, fell in the sea, seven miles from shore.
- 1909—July 25. Bleriot crossed the Channel, Calais to Dover, in 37 minutes.
- 1909—August. G. H. Curtiss won the Gordon Bennett Cup in an international speed race at Rheims. Speed attained, 43 miles per hour, on Curtiss machine. Seven aeroplanes in the air.
- 1909—Wilbur Wright flew around the Statue of Liberty, New York Harbor, September 29th.
- 1909—November 3. Henry Farman broke the world's record for distance, covering 145 miles in 4 hours, 18 minutes, 53 seconds.
- 1909—November 6. Paulhan broke the record for altitude, attaining a height of 970 feet.
- 1910—January 7. Latham reset the world's record for altitude, climbing 3,281 feet; duration of flight, 42 hours 11 $\frac{1}{2}$ seconds.
- 1910—January 12. Paulhan surpassed Latham by climbing to 4,163 feet.
- 1910—January 19. Paulhan demonstrated bombing from an aeroplane.
- 1910—April 20. Sommer established the world's record in flight with three passengers, covering 4.3 miles in the vicinity of Douzy.
- 1910—May 28. Curtiss made Albany-Governor's Island flight, 135.4 miles, in 2 hours 32 minutes. First flight using a river as a guide for an aerial highway.
- 1910—June. Curtiss successfully alighted on water, at Lake Keuka, Hammondsport, N. Y.
- June. Curtiss demonstrated bombing from an aeroplane.

- 1910—July 7. Latham surpassed Paulhan in establishing the world's record for altitude, attaining 4,541 feet, at Rheims.
- 1910—July 13. Curtiss left Atlantic City and, flying over sea, covered 49.6 miles in 1 hour 15 minutes, at an elevation of 1600 feet.
- X 1910—August. McCurdy received and sent wireless messages from an aeroplane in flight, at Sheepshead Bay, N. Y.
- 1910—August 11. Drexel, at Lanark, raised world record for altitude to 6,604 feet.
- 1910—August. Curtiss and Lieut. Fickel demonstrated aerial sharpshooting from an aeroplane, at Sheepshead Bay, N. Y.
- X 1910—September 23. Chavez passed over the hospital at Simplon (Alps), at 2,000 m.; crossed the pass at Dondo, flying toward Italy, and landed at Domodossola. First aviator to cross the Alps.
- 1910—October 15. Leblanc broke the speed record—1 mile in 53 seconds.
- 1910—October 16. Wynmalen Dufour made long distance flight of 285 miles in 9 hours.
- 1910—December 9. Legagneaux set altitude record for the year—19,171 feet at Pau. ✓
- 1910—December 30. Labuteau set distance record for the year—362 miles at Buc.
- 1911—Curtiss successfully rose from the water, and made a sustained and controlled flight, after experiments extending over several years.
- X 1911—January 18. Eugene Ely alighted on, and flew from the deck of a battleship, at San Francisco.
- 1911—January 29. MacCurdy flew from Key West to shore off Havana; 99 miles in 2 hours.
- X 1911—February 23. Curtiss flew from land to water and from water to land, at San Diego, Calif.
- 1911—June 28. Lincoln Beachey flew over Niagara Falls and thru the Gorge. —
- 1911—September 4. Garros set altitude record for the year—12,959 feet, at Parame.
- 1911—September 8. Helen flew over the Lhinnery-Gidy course, a distance of 1,252 kms. in 14 hours 7 minutes. Longest flight of the year.
- 1911—December 24. Gobe set distance record for the year—459 miles at Pau.
- 1911—C. T. Weymann won the Gordon-Bennett prize, flying a Nieuport monoplane at 80 miles per hour.
- 1911—Prier flew from London to Paris, 290 miles, without a stop.
- 1911—December. Third Paris Aero Show, in which 28 makes of machines were exhibited. Twenty monoplanes were shown, and fourteen biplanes. Average horse power was about 60.
- X 1912—January 10. R. C. Fowler flew across the continent from Jacksonville, Fla., to San Francisco, Calif., a distance of 2,232 miles in 151 days. *Wright*
1905-11 - C. P. Rodgers ~~First~~ *transcontinental flight.*
- 1912—June 12. S. Christoferson made the first start from a roof, Portland, Ore., in a Curtiss machine.
- 1912—July 12. Lieut. Andreadi flew from Sebastopol to Odessa and then to Petrograd, covering 1,860 miles in 27 days.
- 1912—July 19. Lieut. Lybousky flew from Sebastopol direct to Petrograd, covering 1,612 miles in 30 days.
- 1912—September 11. Fourny set the distance record for the year—627 miles at Etampes.
- 1912—October 17. Birtch made a tour, Denmark, covering 1,240 miles in 15 days.
- 1912—December 11. Garros set altitude record for the year—18,480 feet at Tunis.

1912—December 14. Janus flew from Omaha to New Orleans, 1,970 miles in 39 days.

1912.—Jules Vedrines won the Gordon-Bennett prize, flying a 160 horse power Deperdussin monoplane, at 105 miles per hour.

1913—January 25. Bielovucic on a Hauriot machine,, crossed the Alps.

1913—March 11. Perreyon set altitude record for the year—19,270 feet at Buc (France).

1913—Prevost won the Gordon-Bennett prize, flying a 200 horse power Deperdussin monoplane at 126.59 miles per hour.

1913.—April Monaca Meet, for over-water machines. The average horse power of motors used was 117; the maximum being the Salmson 200 H. P. in the Briguet.

1913—May. Prince Henry Meet (German). Average horse power used by competitors was 94.

1913—May. Robert Fowler flew across the Isthmus of Panama, following the line of the canal.

1913—June. Brindejone flew a Morane-Sauliner monoplane from Paris to Warsaw, stopping at Berlin. Covered 933 miles in 11 hours, including stops.

1913—June. Verplank and Haven made an all-over water trip from Chicago to Detroit, following the Great Lakes. Distance, 880 miles.

1913—September 1. Pegoud made the first voluntary loop-the-loop, in a Bleriot monoplane.

1913—December. Sopwith produced the first small high-speed biplane of the "scout" class. Speed, 92 miles per hour. Fitted with an 80 H. P. Gnome rotary motor; landing speed, 37 miles per hour. Total gross weight, 1,040 pounds with a supporting area of 240 square feet.

1914—April. The Sopwith Scout won the Monte Carlo races. Refitted with twin floats and a 100 H. P. motor. Speed, 75 miles per hour.

1914—July. Trials of the "America," a Curtiss flying boat, built to attempt a flight across the Atlantic. Gross load, 5,000 pounds; air speed, 65 miles per hour. Two motors used, each driving one propeller. The boat was a success.

1916—Curtiss Triplane Flying Boat, weighing 22,000 pounds (fully loaded), built and sent to England for trials. This machine flew successfully.

1914-'18—Period of the War. Development of machines for distinctive functions:

(a) Speed Scouts and Single-seat Fighters:

Spad, Nieuport, Morane Parasol, S. E. 5, S. V. A., S. I. A., Albattross (D class), Rumpler, Fokker.

(b) Two-Seater Combat Machines:

Bristol, Spad, Salmson, DeHaviland, Curtiss Triplane 18-2, Albattross (G class), Rumpler, D. W. F., L. V. G., Roland.

(c) Reconnaissance and Day Bombing:

Breguet, Voisin, Farman, W. A. (English).

(d) Night Bombers:

Handley Page, Caproni, Candron, Gotha, Friedrichshafen, Zeppelin (aeroplane.)

(e) Coast Patrol:

Curtiss Flying Boats, Macchi, F. B. A., Curtiss H. A. Hydroaeroplane, Lehner, Ago (Hydro).

(f) Training Planes:

(1) Primary—Curtiss JN, Standard JI, Avro, Farman.

(2) Speed—Thomas Morse, S-4-C.

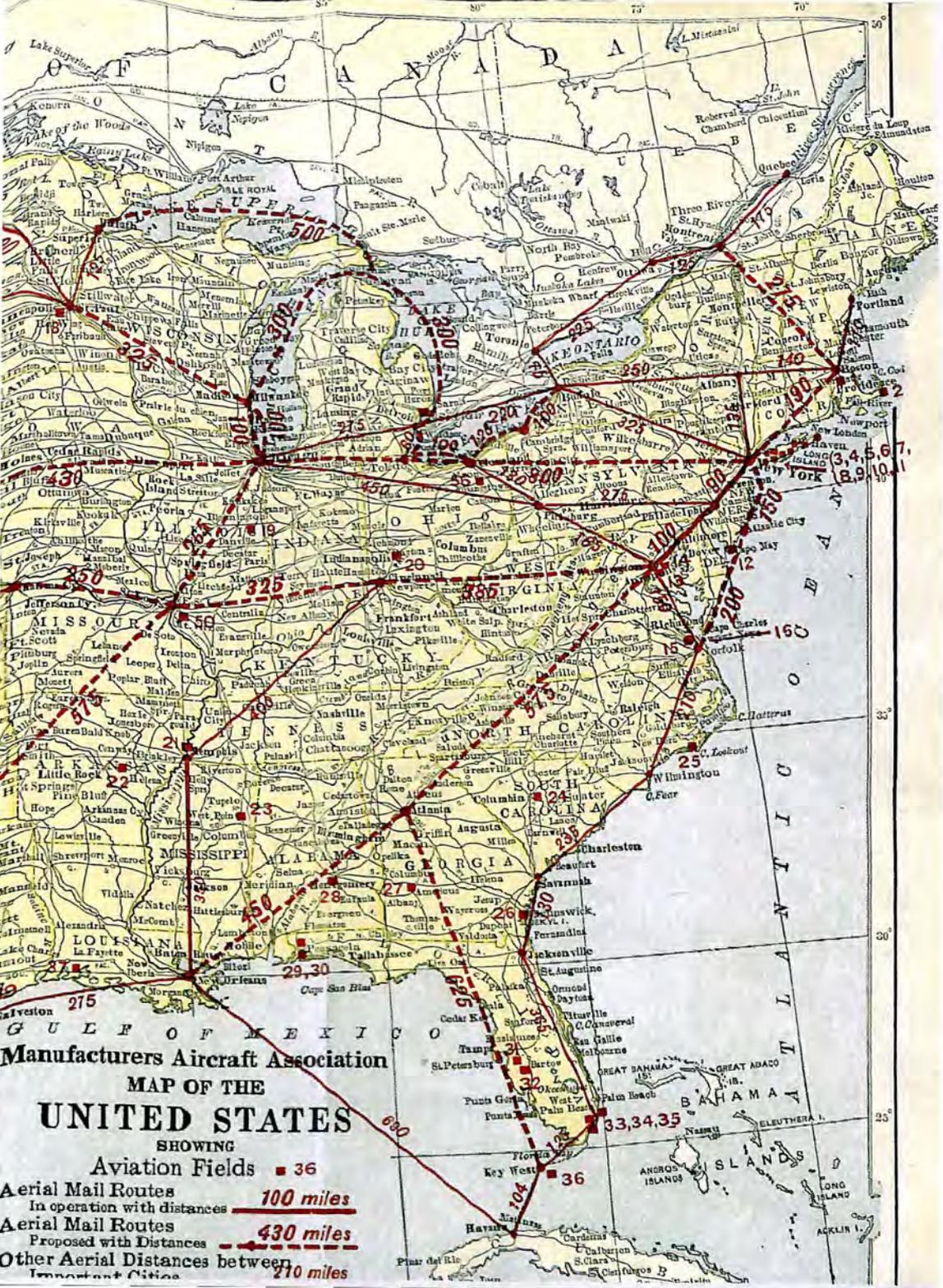
IMPORTANT EVENTS IN MILITARY AERONAUTICS

- 1794—June 23. Ascent by French captive balloon L'Entreprenant during the battle of Maubeuge, under the direction of Coutelle.
June 26. Ascent of the L'Entreprenant during the battle of Fleurus, gaining military information.
- 1796—September 3. Balloons with Jourdan's army (French) made ascents in front of Andernach and Ehrenbreitstein, and were captured by Duke Karl's Austrian army at Wurzburg.
- 1798—The first company of French Aerostiers ordered to Egypt. Destruction of balloon materials in the battle of the Nile, by the English. Napoleon abandoned military aeronautics.
- 1799—The French Aerostiers sent up several Montgolfieres from forts in Cairo.
- 1849—Austrian bombardment of Venice with balloon torpedoes. At the suggestion of Uchatius, an artillery officer, the range of the besieging batteries being insufficient to bombard the town, Montgolfieres made of paper were used. Each could lift 70 pounds, and each carried bombs weighing 30 pounds for 33 minutes. Position was chosen on the windward side. A trial balloon was liberated for a course laid out on a chart. Then a balloon with a bomb was liberated, after timing the fuse. By this means, bombs fell in the town (one in the market place) with great moral effect.
- 1859—June 24. Lieuts. Godard and Nadar (French) ascended in a captive balloon at the battle of Solferino. In the latter ascent he detected some important movements of the enemy, taking photographs while in the air.
- 1861—Lowe (U. S. A. Civil War) made a free ascent after a defeat near Manasses, and discovered position of victorious Confederates, showing the falseness of a report that their army was making a general forward movement. First attempt at heliography from a balloon.
- 1862—A balloon division reconnoitered for MacClellan's army (U. S. A. Civil War). Ascents and descents under heavy artillery fire in various engagements.
May 4. A balloon showed that Confederate General Magruder had left his position during the night.
May 24. General Stoneman ascended, and from the balloon directed artillery fire. (The first instance of the kind.)
May 29. Important work by balloons at Chickahominy, and later at Fair Oaks and Richmond, where a balloon was attached to a locomotive and moved from place to place.
August 16. Discovery by a balloon of the fleet under Wilkes in the James River.
- 1869—During siege of the Duke v. Aidzu's fort at Wakamatzu, by the Japanese Imperial troops, besieged sent up a kite with a man who dropped explosives.
- 1870—Siege of Paris. Between September 23, 1870 and January 28, 1871, 68 balloons got out of Paris. Two German balloon detachments, with balloons purchased from England, attached to the army before Strassburg. One ascent was made on September 24.
- 1876—Small captive balloons were used in war by Japan.
- 1884—A French balloon section of four balloons saw service in Tonkin, and were used in the battle of Hong-Hoa.
May 9. Formation of the Prussian Military Balloon Division.

- 1885—Major Elsdale in command of balloons accompanied Sir C. Warren's expedition to Soudan and Bechuanaland. A balloon detachment was sent to the Soudan under Major Templer and Lieut. Mackenzie. The hydrogen was sent from Chatham compressed in cylinders. Ascents were made during the march to Tamai. A German military critic said of this work, "Practical application of ballooning left nothing to be desired."
- 1887—Italian army used balloons successfully in Abyssinian operations.
- 1898—United States war with Spain. Ascents at Santiago. Useful observations July 1. A captive balloon, for the first time, is destroyed by artillery.
- 1899—At the beginning of the campaign against the Boers, the British used captive balloons and Baden-Powel kites.
- 1900—Balloon Section I, under Capt. Heath, was sent to Natal. On the night of January 18 attempted to discover Boer position on the Tugela with the help of searchlights. Balloons were used during the battles of Vaalkrantz, Spion Kop and Springfontein. On February 10 a balloon was shot down by Boer artillery. Balloon Section II, under Capt. Jones and Lieuts. Grubb and Earle, was ordered to join Methuen's army. Ascents were made before Magersfontein. Balloons accompanied Lord Roberts to Paardeburg, and helped to locate Cronje, and directed artillery fire during five days' observations. Balloons were constantly under fire. Balloon Section III, under Lieut. Blakeney. Balloon used at Fourteen Streams.
- 1900—French and English balloons used to advantage in the campaign against China.
- 1900—Chinese balloons and stores fell into the hands of the Russians at the capture of Tientsin.
- 1904—Japan vs. Russia. A balloon division at Port Arthur. Here a kite-balloon was used for the first time in war. A Russian naval balloon division sent to Vladivostock,, and a balloon company to Manchuria. Ascents were made at the battle of Liaoyan. A Russian balloon was under fire at the battle of Mukden. Very useful work was done.
- 1909—Spanish kite-balloon used in operations against the Moors.
- 1911—In fighting on Mexican frontier aeroplanes were used. Spain, in Morocco campaign.
- 1912-'13—Balkan War. Bulgaria, Greece, Roumania, Servia, and Turkey. Italy used aeroplanes, airships and kite-balloons in Tripoli campaign.
- 1914-'18—General World War. Aeroplanes, kite-balloons and Blimps devolved into an important universal arm of offensive and defensive service.

The following is a list of the dates when the various Powers adopted ballooning for military use:

1783—France.	1884—Spain.
1807—Denmark.	1885—Italy.
1783—France.	1886—Belgium.
1807—Denmark.	1886—China.
1812—Russia.	1886—Holland.
1849—Austria.	1888—Servia.
1861—United States.	1893—Roumania.
1862—Great Britain.	1897—Switzerland.
1869—Japan.	1897—Sweden.
1870—Germany.	1902—Morocco.



Manufacturers Aircraft Association

MAP OF THE UNITED STATES

SHOWING Aviation Fields ■ 36

Aerial Mail Routes In operation with distances 100 miles

Aerial Mail Routes Proposed with Distances 430 miles

Other Aerial Distances between Important Cities 710 miles

AERIAL MAIL TO-DAY AND TO-MORROW

THE day of experiments has passed in the project of an aerial mail service. To-day the use of the airplane in the carrying of Uncle Sam's mail is recognized not only as a sound practical venture, but as a business necessity. Nor are the government authorities to be content, apparently, with the connecting of a few large cities, merely as a spectacular undertaking. No exclamations can be aroused these days over the thought of delivering letters and parcel post from New York to San Francisco, from North to South, by means of air routes. That, in fact, is the very plan, or part of the plan, which is embodied in Postmaster General Burleson's report, issued last December.

Mr. Burleson's recommendation provides for an even more elaborate aerial mail service than the general public imagined would be attempted. The post-office department appreciates, it would seem, the unlimited possibilities offered by the manufacturing and operating skill of American aeronautical construction.

In Mr. Burleson's report it was revealed for the first time that the Washington-New York aerial mail route, which the Postmaster General described as a "working laboratory," and the tentative routes connecting New York and Boston and New York and Chicago are merely links in a system which will not only connect New England with southern Florida, but will be extended through the West Indies to both Central and South America. The linking up of a system connecting San Francisco and Western points and the leading Northern and Southern cities is also outlined. Through the development of the mail service the government has its first and best opportunity to establish America's aerial industry on a sound and progressive peace basis. Whether this opportunity will be realized depends on the attitude of Congress. A bill introduced before this body in December provides that for the fiscal year beginning June, 1919, \$2,185,000 shall be appropriated for the furtherance of aerial mail delivery under the auspices of the Post Office Department. Final action has not yet been taken on this bill.

A glimpse into the plans of Mr. Burleson, however, indicates the support which the government must provide if an aerial mail service is to become a reality.

Mr. Burleson leaves no doubt as to his belief in the practicality of aerial mail delivery. With the establishment of a regular and dependable service between Washington and New York on May

15, 1918, he says, the transmission of mail by aeroplane became a "permanent and practical feature of the air service." One round trip daily, except on Sunday, has been made without fail. From Washington to New York the journey has been performed on an average of two hours and thirty minutes, and from New York to Washington in two hours and fifty minutes, the difference being due to the resistance offered by prevailing winds. An average of seven and three-quarters tons of letter mail is carried each month. Stops for an exchange of mail on each trip are made at Philadelphia.

"By this service," says Mr. Burleson's report, "the mail between New York and Washington is advanced from two and a half to three hours over the train service." In addition to the aeroplane mail carried there is dispatched daily from Washington to New York letter mail from Southern connections made up for carrier districts in New York. This mail is thereby delivered to all parts of New York on the same afternoon, instead of the following morning.

The aerial mail service was inaugurated with the co-operation of the War Department, which furnished the machines and the aviators and conducted the flying and maintenance operations, but on August 12, 1918, the entire operation was taken over by the Post Office Department and the work was performed by this department with its own equipment and personnel.

"It gives great pleasure to report," continues Mr. Burleson, "that the high standard of daily perfect flights which the army succeeded in gradually establishing is being maintained by the Post Office Department, regardless of weather conditions."

A better view of the aerial mail future might have been gained had Mr. Burleson's report not been written before the armistice was signed. He makes the statement, for instance, that "the Post Office Department only awaits the day when the aircraft production of this country can more than supply the needs of our own army and the Allies" to make effective the full aerial mail program of the United States. That day, fortunately, has arrived—in the sense that the producing or operating phases of the program need cause no worry to the Post Office Department.

Mr. Burleson proposes, first, to establish an aerial mail service connecting the principal commercial centers of the country by a system of trunk lines and feeders, and, second, to connect this country with the West Indies and Central and South America. The trunk lines decided upon may be indicated as follows:

1. New York to San Francisco, with feeders from:
 - (a) Chicago to St. Louis and Kansas City.
 - (b) Chicago to St. Paul and Minneapolis.
 - (c) Cleveland to Pittsburgh.
2. Boston to Key West, with feeders from:
 - (a) Philadelphia to Pittsburgh.
 - (b) Washington to Cincinnati.
 - (c) Atlanta to New Orleans.
3. Key West, via Havana, to Panama.
4. Key West, via West Indies, to South America.

Mr. Burelson said that the Boston-New York division and the Washington-Atlanta and Atlanta-Key West routes would be established when it was found that their operation would not conflict with war needs. At the time of the report, according to Mr. Burelson, the New York-Chicago division had been carefully worked out, aeroplanes of 650-pound mail capacity had been released, hangars ordered, landing fields obtained and the route ordered established before the close of 1918. In the work of charting between Chicago and New York a record flight was made—less than fourteen hours, including all stops en route.

Reconnaissance proved, according to the report, that it will be feasible to maintain a daily nine-hour schedule between New York and Chicago. This is compared with the 21-hour schedule of the Twentieth Century Limited! Little wonder that such a glowing future is seen in the possibilities of the aeroplane.

Cleveland, it is planned, will be the principal mail stop between Chicago and New York. The feeder routes from Chicago to St. Louis, Kansas City, St. Paul and Minneapolis, said Mr. Burelson, and the rest of the trunk line from Chicago to San Francisco "will be worked out during the ensuing year, with a view to their immediate inauguration at the close of the war."

That the prospect of a mail service between this country and Latin America is a definite one is indicated by Mr. Burelson's statement that negotiations for the conclusion of special aerial mail conventions between the United States and the foreign nations involved are now in progress. "It is realized," states Mr. Burelson, "that these overseas routes will require the most powerful aeroplanes with wireless and special construction to make them safe over the seas, but the enormous commercial advantage that will result by materially reducing time between this country and Central and South America will justify the expenditure that such a service will entail."

Mr. Bureson quotes the act of May 10, 1918, fixing the postage on air mail at a sum not exceeding twenty-four cents an ounce or fraction of an ounce. Upon the beginning of the service May 15th, the maximum charge authorized by law was required, ten cents being for special delivery service; but it was found that twenty-four cents exceeded the cost of the service and the rate was reduced on July 15th to sixteen cents for the first ounce and six cents for each additional ounce or fraction thereof, ten cents of the initial charge being for special delivery service.

Detailed financial tables accompany the report, although they give little idea of the ultimate cost of the aerial mail service.

PERFORMANCE OF AVIATORS, NOVEMBER, 1918

Total possible number of flights	104
Total possible mileage	11,336
Total perfect (uninterrupted) flights made	102
Total interrupted flights made	2

Pilot	PERFECT FLIGHTS		FORCED LANDINGS		TOTAL	
	No.	Miles	Interrupted Flights	Uncompleted Flights	No.	Miles
Dana C. DeHart	28	3,052	0	0	28	3,052
Robert F. Shank	16	1,744	0	0	16	1,744
Max Miller	32	3,488	0	0	32	3,488
Edw. V. Gardner	12	1,308	0	2	14	1,526
Louis Gertson	4	436	0	0	4	436
Lawton V. Smith	10	1,090	0	0	10	1,090
Total	102	11,118	0	2	104	11,336

SERVICE AND UNIT COST, OCTOBER, 1918

Airplane No.	Gallons of Gas	TOTAL TIME RUN		Total Miles Run	Miles Run per Gallon of Gas	Cost per Hour	Cost per Mile
		Hours	Minutes				
1	411	36	33	2,630	6.39	\$29.50	\$0.4100
2	451	38	13	2,954	6.54	29.65	.3836
4	488	39	51	2,964	6.07	31.81	.4276
5	175	24	34	894	5.10	43.38	1.1921
6	295	20	46	1,452	4.92	47.11	.6738
38262	18	..	..	..	..	..	..
38274	241	17	50	1,190	4.93	45.00	.6743
38275	45	2	09	180	4.00	299.95	3.5827
38278	42	3	08	320	7.61	192.21	1.8820
39365	60	..	..	..	..	..	..
39366	67*	0	58	87	1.29	574.54	6.3837
Total	2,293	184	02	12,671	5.52	\$53.48	\$0.7767

*Leakage.

AIR MAIL OPERATION, NOVEMBER, 1918

Date, 1918 November	Miles Flown (1)	HOURS OF FLYING (2)		MAIL CARRIED (3)		Per Cent of Per- formance (4)	ARRIVAL (5)	
		Hours	Minutes	A	O		Wash.	N. Y.
1	436	5	58	26 1/2	609	100	4.30	2.25
2	436	5	54	40	509	100	3.35	2.40
4	436	6	03	50	572	100	3.54	2.10
5	436	5	37	32 1/2	531	100	2.55	2.59
6	436	5	49	31	603	100	2.48	3.12
7	436	5	30	35	598	100	3.00	2.50
8	436	5	36	35 1/2	605	100	2.45	3.05
9	436	6	33	44	575	100	4.10	2.25
11	436	5	38	41	444	100	3.01	2.56
12	436	5	18	31 1/2	576	100	2.43	3.03
13	564	7	14	29 1/2	666	100	3.10	2.40
14	436	5	44	30	567	100	3.48	2.20
15	436	5	34	31 1/2	589 1/2	100	3.40	1.55
16	436	6	20	30 1/2	507	100	4.12	3.05
18	201	3	04	31	529	50	11.25 P.M.	2.50
19	436	5	51	35	625	100	4.00	2.00
20	436	6	34	34 1/2	305	100	4.04	2.40
21	436	5	51	29 1/2	582	100	3.45	2.40
22	436	5	48	35 1/2	626	100	3.20	2.35
23	654	9	18	38	821	100	3.25	3.08
25	872	12	30	30 1/2	1,236 1/2	100	4.01	2.42
26	654	8	46	34	893 1/2	100	3.21	2.53
27	436	6	49	30	624	100	4.08	2.50
28	436	5	21	31 1/2	508	100	3.26	2.47
29	436	5	24	28	615	100	3.40	2.00
30	436	6	02	41	623	100	4.32	1.50
	12,101	164	06	887	15,966 1/2			

NOTE.—No. hours of dead flying for the month, 10 hours 41 minutes.

EXPLANATION OF TABULATION

- (1) *Miles flown.*
 Leg from Washington to Philadelphia 128 miles
 Leg from Philadelphia to New York 90 miles

Miles flown for the day, whether one, two, three or four legs of the trip have been made. The aim is to get exactly the number of miles flown in connection with the mail service each day. Therefore, mileage of partial trips has been indicated.

- (2) *Hours of flying.*—Includes the actual hours and minutes the machine is in the air with mail.
- (3) *Mail carried.*—In this column, under A, gives pounds of aeroplane mail; and under O, gives pounds of ordinary mail.
- (4) *Per cent of performance.*—Round trip Washington-New York consists of four legs, each leg valued at 25 per cent if completed by aeroplane and not by train before close of day.

COST OF OPERATION AND MAINTENANCE, OCTOBER, 1918

Airplane No.	Gas	Grease and Oil	Office Force	Motor Cycle, Trucks	Refr. Light Fuel, Power Telephone and Water	Miscellaneous	Pilot's Actual Time	MECHANICS AND HELPERS		Repairs and Accessories	Interest on Investment	Depreciation/Overhaul Charge	Total
								On Plane	Shop Time				
1	\$130.23	\$26.75	\$39.50	\$31.33	\$39.55	\$61.25	\$241.65	\$187.61	\$40.88	\$64.40	\$101.97	\$113.49	\$1,078.51
2	137.00	44.31	39.50	31.32	39.55	61.26	252.50	191.63	40.88	79.93	101.97	113.49	1,133.34
4	148.38	37.87	39.50	31.32	39.55	61.26	263.28	195.80	40.88	194.35	101.97	113.49	1,267.65
5	53.00	12.21	39.50	31.32	39.55	61.26	162.30	207.30	40.88	203.00	101.98	113.49	1,065.79
6	90.05	22.19	39.50	31.32	39.56	61.26	137.25	163.37	40.87	137.55	101.98	113.49	978.40
38262	5.58	2.20	39.50	31.32	39.56	61.26	...	72.56	40.87	730.36	101.98	113.48	1,238.67
38274	73.46	14.82	39.50	31.32	39.56	61.26	117.85	140.41	40.87	27.99	101.98	113.48	802.50
38275	13.50	2.61	39.50	31.32	39.56	61.26	14.25	114.25	40.87	72.31	101.98	113.48	644.89
38278	12.87	5.36	39.50	31.32	39.56	61.26	20.75	130.31	40.87	5.00	101.98	113.48	602.26
39365	19.50	.....	39.50	31.32	39.56	61.26	.....	12.40	40.87	14.49	101.98	113.48	474.36
39366	20.10	.....	39.50	31.32	39.56	61.26	6.40	64.67	40.87	36.25	101.98	113.48	555.39
	\$703.67	\$168.32	\$434.50	\$344.53	\$435.12	\$673.85	\$1,216.13	\$1,480.31	\$449.62	\$1,565.63	\$1,121.75	\$1,248.33	\$9,841.76

A PORTION OF
SECOND-ASSISTANT POSTMASTER PRAEGER'S
SPEECH AT THE M. A. A. BANQUET

I CAN say frankly, that the Post Office Department is not in the market for any products of your factories. What you are really doing is the putting out of thinly disguised war planes. What the Post Office Department will need is a plane capable of meeting the needs of commerce, and as far as we are concerned, we are going to continue to salvage such of the material as the Secretary of War and the Secretary of the Navy will turn over to us, adapting their methods to mail needs. We can just as well do that as to buy new planes built along the old lines.

So, to-day, I am satisfied you will have a machine that will not only meet the wants of the Post Office Department, but of commerce generally. It should be a machine that will not have marvelous speed, terrific climb, or great ceiling, at the expense of carrying capacity, or stability, or strength of construction. Also, it must be a machine that will overcome the radiator troubles, and those score of troubles that develop in the air and force landing.

Another thing, a commercial machine should be able to land in a city lot near the heart of a town, instead of on a 40-acre field where the commuters live. The commercial machine will have to be one of two things: it will have to be a ship that will overcome these troubles that create forced landings, or it will have to be a ship that can settle down on any character of territory, where the repairs can be made pretty much as an automobile can be driven up to the curb and repaired, without the danger of cracked ships or cracked machines, as we have in airplanes when they make forced landings on unprepared fields.

When you get such a ship—and I don't think it will be very long until you solve those problems—then you will have a machine which will command a market outside of the Government needs, which will be in such demand that all the orders that you get from the War Department or the Navy, or the Post Office Department will pale into insignificance in comparison with what you will get from the commercial world.



Photo. by Underwood & Underwood

THE WEATHER BUREAU AND AVIATION*

BY WILLIS RAY GREGG, Meteorologist, U. S. Weather Bureau

FOR several years prior to the war with Germany the United States Weather Bureau included in its regular programme of observations such investigations of free air conditions as the funds provided by Congress enabled it to make. These investigations were made for the most part by means of kites, although in several instances captive balloons and soundings, or free balloons, were also used. The most important series of observations were conducted at Mount Weather, Va., and Drexel, Neb., by means of kites and captive balloons and at several places in the Central and Western States by means of sounding balloons. In all cases small, recording instruments, known as meteorographs, were carried to as great heights as possible and furnished data as to conditions of pressure, temperature, humidity and wind at various altitudes, at different times of the day and year and under varying types of weather at the earth's surface. All of the observations thus obtained were published in detail and discussed in the Bulletin of the Mount Weather Observatory and in the *Monthly Weather Review* or its Supplements. The five-year summary for Mount Weather, Va., included a presentation of average free air conditions of wind, with

*Specially prepared for the Manufacturers Aircraft Association Year Book by Mr. Gregg, in charge of Aerological investigation for the United States Weather Bureau, under Prof. Charles F. Marvin, Chief of Bureau.

respect to surface wind and weather conditions, in such form as to be readily accessible for the use and information of aviators.

As soon as a state of war was declared to exist between this country and Germany, it became at once apparent that there would be a very large expansion in aviation and that, therefore, there should be a corresponding development in aerological investigations, in order to furnish data not only for average conditions but also for specified times and places. Accordingly, on May 12, 1917, Congress included in the Army bill for the fiscal year 1917-18, an item "For the establishment and maintenance by the Weather Bureau of additional aerological stations, for observing, measuring and investigating atmospheric phenomena in the aid of aeronautics, including salaries, travel, and other expenses in the city of Washington and elsewhere, \$100,000, to be expended under the direction of the Secretary of Agriculture."

Under the provisions of this Act the Weather Bureau increased the number of its kite stations from one to six. At these stations daily records of free air conditions are obtained, and the data computed and telegraphed to the Central Office for use in forecasting. Moreover, in co-operation with the Meteorological Section of the Signal Corps, aerological stations were established at most of the army training fields. Now that the war has ended, the work at many of these stations is being taken over by the Weather Bureau and, in other cases, is being transferred to other localities, better situated with respect to aerial mail and other trans-continental route. Observations are made with small rubber "pilot" balloons, whose movements through the air are followed by means of theodolites. With the measurements thus made it is possible to determine quickly and accurately the wind direction and velocity at various heights above the earth's surface. These observations are being made regularly twice each day at about twenty-five stations well distributed over the eastern part of the country. Beginning with December 1, 1918, the afternoon observations were at once computed, and telegraphed to the Central Office at Washington, D. C., the data thus furnished including wind direction and velocity at the surface, and at altitudes above it of 250, 500, 1,000, 1,500, 2,000, 3,000 and 4,000 meters, together with the height of lower clouds, if any, and information as to the character of weather at the surface. Bulletins, based on these reports and giving current and probable future conditions of winds at various levels, have been furnished daily to the aerial mail service at Washington, D. C., New York, N. Y.,

Cleveland, Ohio, and Chicago, Ill. In addition, special advices have been given for the benefit of other Government and private aviation enterprises. There is no reason to doubt that, with the extension of the Aerial Mail Service to points farther south and west and with the expected large development of commercial aviation, the information that can be furnished by the Weather Bureau will become increasingly important.

There is still another line along which such aid will be of the utmost significance, viz.: trans-Atlantic flying. Plans are now under way, whereby reports of surface and free air conditions may be received from Europe and from ships at sea, thus enabling the Weather Bureau to furnish advices as to the best time for flights, the altitudes at which the greatest help will be given by the winds and the direction in which the airplane should fly, in order that the resultant movement, under the influence of the wind and of the "set" of the airplane, may be along any desired course.

In addition to the activities above outlined, the Weather Bureau has had numerous calls for data showing average free-air conditions in their relation to surface pressure distribution, etc. The need for such data in concise form was shown to be particularly urgent during the First Pan-American Aeronautic Exposition at New York, February 8 to 15, 1917. To meet this need a manual for aviators, entitled "Meteorology and Aeronautics," was prepared by the Weather Bureau during that year and published by the National Advisory Committee for Aeronautics as Report No. 13. In the early part of 1918 supplementary papers on "Free Air Barometric and Vapor Pressures, Temperatures, and Densities over the United States" and "The Turning of Winds with Altitude" were published by the Weather Bureau. All of these papers have been given wide distribution among aviators and have filled a long-felt want.

VARIATION OF VELOCITY WITH ALTITUDE
(DURING THE DAY)

Elevation	Velocities in miles per hour				
Surface	5	10	15	20	25
500 feet	7	15	21	28	35
1000 feet	8	18	26	34	43
2000 feet	8	18	28	37	47
3000 feet	8	18	29	40	49
4000 feet	10	19	29	40	50
5000 feet	13	20	29	40	50

CLOUDS AND CORRESPONDING HEIGHTS

Height	Name	Description
Sea-Level to 3000 feet	Stratus	Elevated fog.
4500 feet to 6000 feet	Cumulus	Rounded heap
4500 feet to 24000 feet	Cumulo-nimbus	Tower-like clouds, with round tops and flat bases.
6400 feet	Strato-cumulus	Rolls of dark clouds.
6400 feet	Nimbus	Masses of dark formless clouds.
10,000 feet to 21,000 feet	Cirro-cumulus	Fleecy cloud—mackerel sky.
27,000 feet (average height)	Cirro-stratus	Fine whitish veil, giving halos around sun and moon.
27,000 feet (average height)	Cirrus	Isolated feathery white clouds.

CLOUD MOVEMENT—BLUE HILL OBSERVATORY

BOSTON, U. S. A.

Cloud Level	Height	Hour-Speed—M. P. H.
Stratus	1,676	19
Cumulus	5,326	24
Alto-Cumulus	12,724	34
Cirro-Cumulus	21,888	71
Cirrus	29,317	78

VARIATION OF DIRECTION OF WIND
AND ALTITUDE

Upper region winds vary in direction from those near the earth's surface. The amount of deviation is given approximately in the tabulation:

Elevation	Deviation to Right in Degrees	Directions			
Surface	0	N	E	S	W
500 feet	5	N $\frac{1}{2}$ E	E $\frac{1}{2}$ E	E $\frac{1}{2}$ S	W $\frac{1}{2}$ W
1000 feet	10	N by E	E by S	S by W	W by N
2000 feet	16	N by E $\frac{1}{2}$ E	E by S $\frac{1}{2}$ S	S by W $\frac{1}{2}$ W	W by N $\frac{1}{2}$ N
3000 feet	19	N by E $\frac{3}{4}$ E	E by S $\frac{3}{4}$ S	S by W $\frac{3}{4}$ W	W by N $\frac{3}{4}$ N
4000 feet	20	NNE	ESE	SSW	WNW
5000 feet	21	NNE	ESE	SSW	WNW

BALLOONS

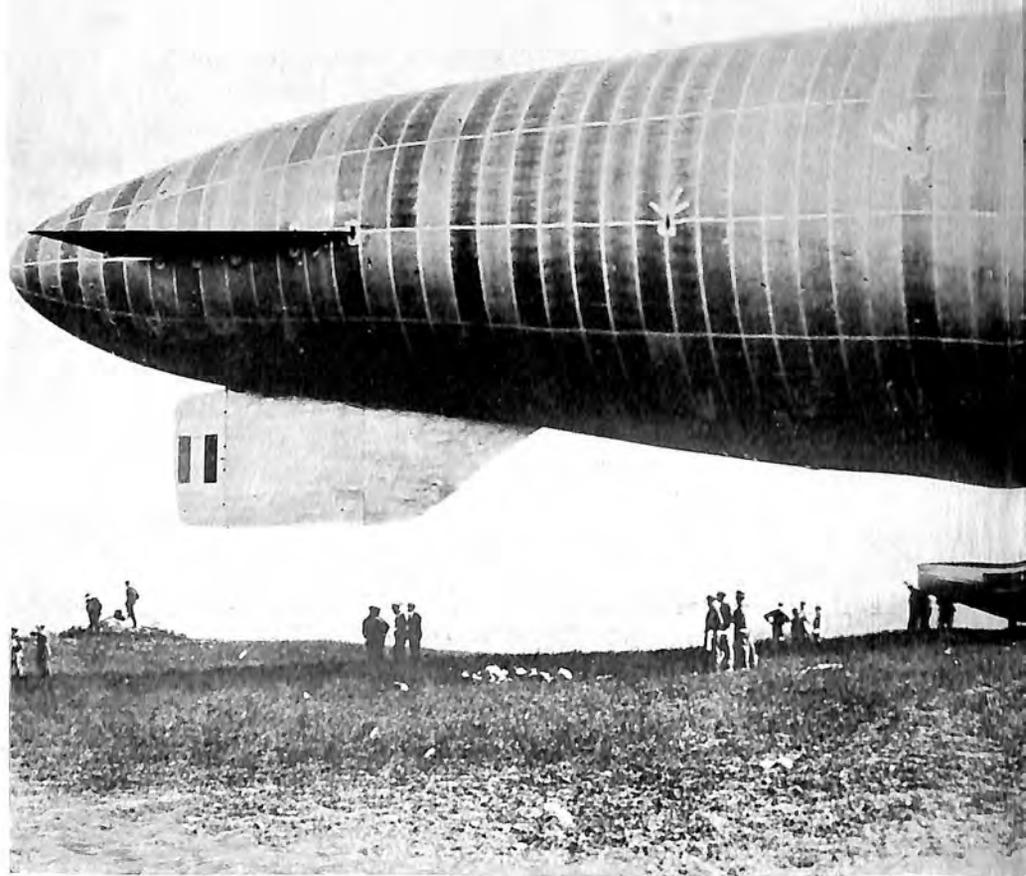
THE discovery of a process by which helium could be manufactured cheaply has recently revived an interest in the airship, the descendant of the earlier balloon. Helium has 92% of the buoyancy of hydrogen, but none of its inflammability. The discovery of an economical process of producing it, during the last summer, accordingly raised the military stock of the dirigible a number of points. And the public generally recalls with interest the ancestor of this type of aircraft, while it speculates as to the practical possibilities of the balloon's descendant.

We are, indeed, apt to forget that the first ascent ever made in the air by man was made in a balloon. We sometimes forget not only this exploit performed by Pilatre DeRozier and Marquis d'Arlandes on November 21, 1783, but also allow the fact to slip our memories that the first craft to navigate the air successfully was a dirigible, constructed by the Frenchman Giffard, which sailed from Paris on September 23, 1852. Dirigibles were navigating successfully at a speed of from 14 to 30 miles an hour, at a time when airplanes were still no more than theory.

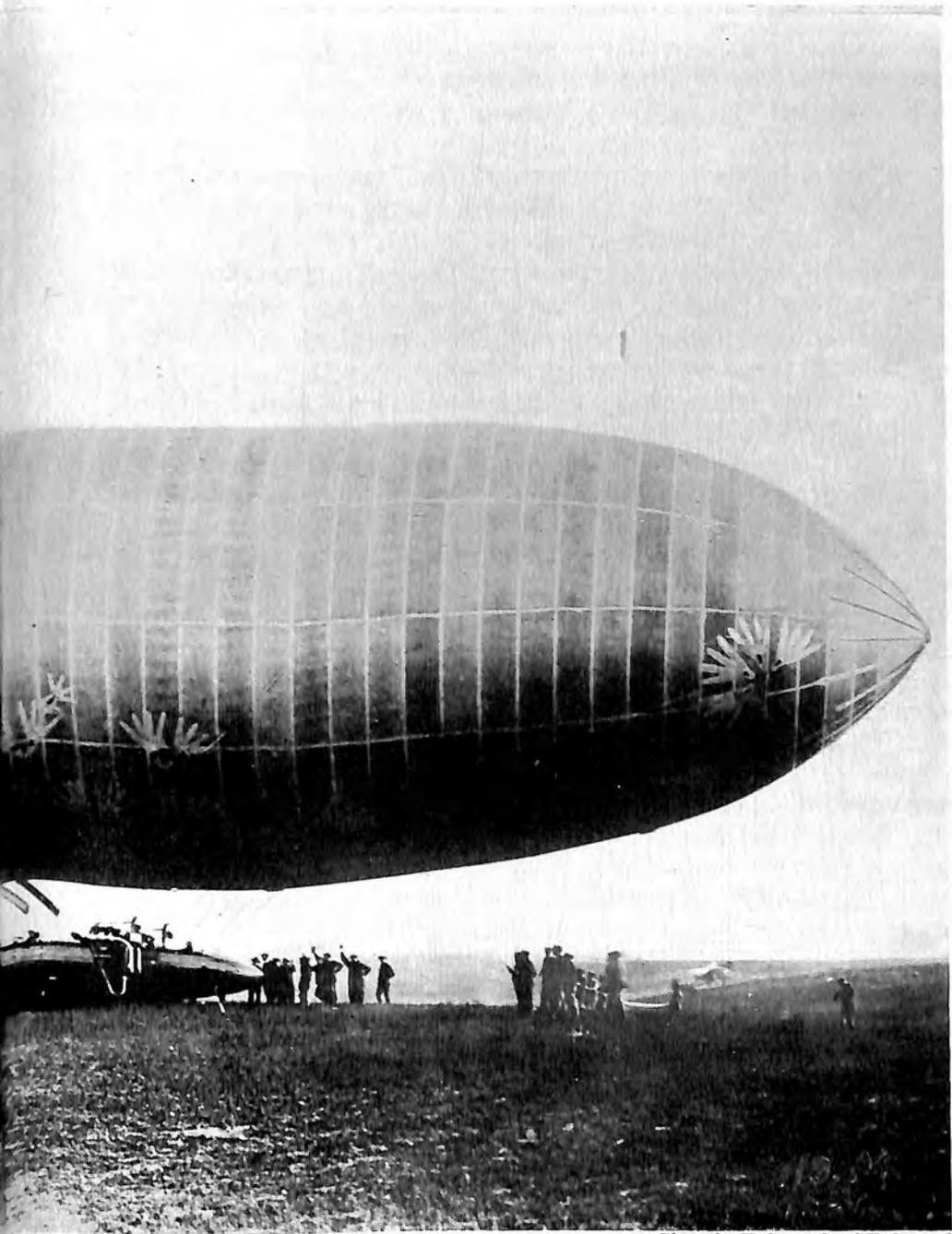
There is no space available in this volume for a history of the balloon. All that can be presented is a brief statement of what the results to date amount to, and what the probabilities of the near future seem to be. The successful use of hot air for inflating a balloon by Joseph Montgolfier and his brother in 1783; the successful appliance of hydrogen gas by the scientist, Charles, a few weeks later; the use of coal gas in 1821 by Charles Greene in England; the effort toward navigability, which persisted through the earlier part of the 19th century and culminated in the Frenchman Giffard's successful flights; and the later achievements of such men as Captain Charles Renard and the Lebaudy Brothers in France, and Gross and Von Parseval and Zeppelin in Germany, and Major Baldwin and Mr. Curtiss in the United States, must be passed off with nothing more than a mention.

The achievements of balloons—both captive and dirigible—during the recent war are distinctly worthy of notice. The Allies used chiefly the captive balloons. These had, in many instances, distinct advantages over the airplane for observation work. They were used in quantity by the French, British and American Armies, and by the Germans as well.

But the outstanding performance of dirigibles during the war was



The Largest Dirigible



Balloon in America

Photo. by Underwood and Underwood

the series of raids which the German Zeppelin made upon England and France. The Zeppelin, indeed, seemed for a while to represent a military instrument, the possession of which the Allied nations might well envy the central powers. But with the discovery that these machines could be brought down with comparative ease by incendiary bullets, Great Britain and France ceased to consider them war instruments of practicality.

Nevertheless, the Zeppelin represented an interesting aeronautical achievement. It had, at the beginning of the war, says Mr. W. Lockwood Marsh, in a recent article in "Aeronautics," a speed of 45 M. P. H., and a capacity of 1,000,000 cubic feet. At the conclusion of the conflict, the speed had increased to 75 M. P. H., and the displacement to 2,000,000 cubic feet.

What is important for the public, generally, is the fact that the Zeppelin lifting capacity had risen to 65 tons, 38 tons of which were available for crew, fuel, ballast, merchandise, etc. Mr. Marsh estimates that 18 tons of this could certainly be used for freight.

This opens up the question of the airship's suitability for commercial undertakings. With a speed of 75 miles per hour, and a carrying capacity many times that of the largest airplane, it would appear to be no unlikely candidate. It has, thinks Mr. Marsh, a number of advantages over the airplane. It has a cruise radius of from 1,000 to 2,000 miles as opposed to the airplane's present 500 to 1,500. It is more comfortable. No one can deny that the accommodation, in even a large airplane, is, to say the least, cramped. "Now, in quite a moderate size non-rigid airship of 400,000 cubic feet, there is ample head-room for a straight walk of 20 to 30 feet from end to end of the car, and in the large rigid airship there is not only plenty of space in the gondola, but one can, if one so desires, take a walk in the keel of 400 to 500 feet in length." The airship, claim its advocates, is no more expensive than the airplane, with regard to cost of construction and fuel, taking into consideration the work done by the two machines. In addition, figures given out by the British Air Ministry show that fewer men are employed in proportion to the distances flown, than is the case with the airplane.

Another advantage which the airship possesses is its ability to fly low. "Even with landing grounds only ten miles apart," says Captain E. M. Maitland of the R. A. F., in an Appendix to the British Civil Aerial Transport Committee's Report, "an airplane would be compelled to fly at a minimum height of about 3,000 feet, whereas an airship can cruise with safety a few hundred feet above the crowd,

which considerably enhances the pleasure of passengers by affording them an opportunity of enjoying the scenery."

Nor need the airship pilot worry about the position of his machine at night or in fog, mist or cloud, suggests the same writer. The airship always remains on an even keel.

Of course the dirigible, being self-sustaining, need never descend on account of motor trouble; and its ability to keep afloat without power enables it to stop in a fog, as whenever fogs occur, no wind will be present.

All these advantages were to some degree apparent before the end of the war. But owing to the inflammability of hydrogen gas, the British Government had decided, in 1915, that dirigibles were not worth building.

The success of the Linde Company's experiments by June, 1918, marked the resumption of dirigible building on the part of Great Britain. "Had the war lasted until spring," says Ladislav d'Orcy in *Aviation*, "an Anglo-American fleet of rigid helium airships would have been dispatched on a bombing campaign against Germany's strategic centers with results which it is easy to imagine." As Mr. d'Orcy points out, the great bouyancy of airships will permit a greater and more effective armament than acting airplanes could carry, and the chances of its destruction in battle by existing agencies of aerial attack would consequently be enormously reduced.

The Navy Department has already indicated its opinion of airships by helium, by a request for four Zeppelin type airships to cost \$1,500,000 each; twelve of a medium size to cost \$250,000 each; and twelve small ones to cost \$75,000 each.

While the helium-filled airship thus promises to become of increasing military value, it must offer itself to any one who has thought upon aviation as a logical instrument for long distance carrying—both passenger and freight.

Even when inflated by hydrogen, the airship was not a dangerous conveyance, except in time of war. With the development of helium, even such danger as existed before will be removed. It can stop flight without descending. It can repair damage to its power plant in the air. It can travel in rain or fog. It can fly at any height that is desired from 100 to 18,000 or 19,000 feet.

Some objection has been offered by those who think that the dirigible can not be used effectively in a strong wind. Captain Maitland believes that any past difficulty experienced in winds has been due to low speed. The speed, he thinks, will from now on reach 75

miles per hour or higher. Some difficulty will be experienced in handling airships on the ground in high winds, because of the large surface which they offer. Revolving sheds, or a simple system of strong moorings would, thinks the British authority, overcome all important difficulties.

Those who advocate the airship as a commercial instrument, say it will be the means of conveyance for long voyages. Crossing the Atlantic or the continent, sailing from Delhi to Cairo, from New York to Valparaiso—the air pilot will make much better headway with the airship than with the airplanes. For shorter flights the heavier-than-air craft will be more desirable. The two types will operate in provinces whose boundaries will be fairly distinct.

The airship of the future, thinks Captain Maitland, will carry crew, fuel, merchandise or passengers to an amount of 50 or 60 tons, and will have a speed of from 90 to 100 miles an hour. When it is remembered that few of the larger airplanes go faster than 90 miles per hour with any considerable load, the descendant of the humble balloon may well be considered as holding possibilities for important future work.

COMPASS POINTS AND THEIR EQUIVALENTS

Table showing the equivalent value in degrees of each fractional division of the compass to the nearest minute of arc:

$\frac{1}{8}$ point equals	1° 24'
$\frac{1}{4}$ point equals	2° 49'
$\frac{3}{8}$ point equals	4° 13'
$\frac{1}{2}$ point equals	5° 38'
$\frac{5}{8}$ point equals	7° 02'
$\frac{3}{4}$ point equals	8° 26'
$\frac{7}{8}$ point equals	9° 51'

IMPORTANT EVENTS IN BALLOON HISTORY

- 1400—Roger Bacon suggested a plan of flotation of a large hollow sphere of very thin copper, to be filled with "etherial or liquid fire." Believed air to have a definite consistency and capable of sustentation like water. No definite record of actual experimentation.
- 1670—Francesco Lana suggested four copper balls of thin walls, and entirely exhausted of air. Balls each to be 20 feet in diameter, and so thin that each weighed less than an equal bulk of atmosphere. Fallacy consisted in the physical condition that the walls would be too thin to withstand atmospheric pressure. The construction may be regarded as the prototype of the modern balloon.
- 1709—August 8. Bartholomeo-Lourenco de Gusmao causes what is probably a hot-air balloon or a gas balloon to rise to ceiling of the Palace of Indies in Lisbon, Portugal.
- 1767—Dr. Black of Edinburgh suggested the use of hydrogen with a thin bladder bag.
- 1782—June 20. Tiberius Cavallo presents a note to Royal Society describing successful experiments with hydrogen-inflated soap bubbles.
November. Stephen and Joseph Montgolfier used a hot-air balloon to lift a load.
- 1783—June 5. At Annonay, France, a balloon of 35 feet diameter, filled with hot air, is sent up by Joseph Montgolfier and his brother, attaining a height of more than one mile.
June 26. At Paris, France, a hydrogen balloon is sent up by the scientist, Charles.
August 30. Charles sent up a 12-foot diameter balloon, made of oiled silk and filled with hydrogen, on the Champ de Mars, Passy.
September 19. Hot air balloon is sent up by J. Montgolfier with sheep, rooster and duck, all landing uninjured.
November 21. At La Muette palace, near Paris, hot-air balloon rises with Pilatre de Rozier and the Marquis d'Arlandes; descends safely in 20 minutes.
December 1. Charles and Roberts hydrogen balloon covers three miles in two hours, leaving the Tuileries and landing near Nesle, France.
December 26. Sebastien Lenormand descends by parachute from the Tower of the Montpelier Observatory.
- 1784—January 19. At Lyons, seven passengers ascend in La Flaselle hot-air balloon, the largest of its type ever constructed—100 x 130 feet.
March 2. Blanchard tried to steer with aerial oars.
August 27. Tytler made the first ascent in England, using a cloth bag covered with varnish.
September 19. Roberts Brothers use fish-shaped balloon, oars and rudder, and changed course 22 degrees in calm air. French experiment.
December 17. Roberts and Charles took up a hydrogen balloon of over 10,000 cubic feet.
General Meusnier introduced the principle of ballonnet, in a balloon equipped with hand-worked propellers. Propelling scheme anticipated by the Roberts Brothers.
Lunardi made the first flight over London.

- 1785—January 7. Jeffreys and Blanchard cross the channel from Dover, landing in the Province of Artois.
- 1812—Leppig uses a fish-shaped balloon, with free propellers. Unsuccessful. Russian experiment.
- 1834—Count de Lennox attempted a balloon flight in a cylindrical balloon 130 feet long, and fitted with twenty oar propellers. French experiment.
- 1836—November 7. Messrs. Robert Holland, Charles Green, and Monck Mason sail in a coal gas balloon in eighteen hours from London to Weilburg, Nassau, a distance of 500 miles.
- 1848—Hugh Bell used screw propellers on a cylindrical balloon, 55 feet long. English experiment.
- 1852—September 23. Henry Gifford makes a voyage with a dirigible from Paris to Trappes and back, with rudder and steam motor. Balloon was spindle shaped, 130 feet long; motor developed 3 horse power. In still air, had speed of 4 m. p. h.; winged propellers used. French experiment.
- 1853—October 4. Felix Tournachan flies the "Géant," a free type balloon of 215,000 cubic feet from Champ de Mars to Meaux, carrying fifteen people. Bag equipped with compensating ballonnet, suggested by M. L. Godard.
- 1859—June 23. Mr. John Wise sails from St. Louis, Mo., to Henderson, N. Y., a distance of 809 miles.
- 1862—September 5. (James) Glaisher and Coxwell ascend 37,000 feet, according to Mr. Glaisher's reckoning. They are credited with about six miles, starting from Wolverhampton, Eng.
- 1869—Henry Gifford made two ascensions in a captive balloon of 450,000 cubic feet capacity, from Habburnham Park.
- 1870—De Lome flew in a spindle-shaped balloon 110 feet long, using screw propellers and sail-like rudder. Apparatus was operable. French experiment.
- 1872—Haenlein attained successful flight with a cylindrical balloon 165 feet long, using a cylinder gas engine of 2.8 horse power. Austrian experiment.
- 1883—Tissandier Brothers successfully drive a spindle-shaped balloon 90 feet long, using a Siemens electric motor. French experiment.
- 1884—August 9. Captain Charles Renard's "La France," dirigible, with 9 H. P. motor, makes successful flight, showing complete control. In seven trials, in the course of two years, it returned to its point of departure five times out of seven. Speed, 14.5 m. p. h. Had the ballonnet of Meusner; used the suspension system of De Lome, and the electric equipment of Tissandier Brothers. Bag was 160 feet long; propeller placed at front; carriage to balance weight of rudder at rear end. French experiment.
- 1886—Woelfert flies with a cigar-shaped balloon, 91 feet long; equipped with a Daimler motor and a two-bladed aluminum propeller. German experiment.
- 1893—Schwartz suggested the use of an aluminum structure. Russian experiment.
- 1895—Schwartz, operating in Germany, built an aluminum airship, 150 feet long fitted with a 12 H. P. Daimler motor.
- 1897—July 11. Andrée's attempt to reach the North Pole, accompanied by Frankel, Svedenborg and Strindberg.
- 1898—Zeppelin built a cigar-shaped rigid airship, 418 feet long, fitted with two 16 H. P. motors. German experiment.
- 1900—July 2. Zeppelin I makes first flight from Lake Constance. October. De la Vaulx makes flight from Vincennes, France, to Korostcheff,

Russia, a distance of 1,193 miles, in 35 $\frac{3}{4}$ hours. (Largest balloon flight recorded to 1911.)

Roze suggests the use of a double airship.

- 1901—July 31. Prof. Berson and Dr. Suring ascend from Berlin to an altitude of 35,425 feet in the hydrogen balloon "Preussen," 300,000 cubic feet.
October 19. Santos Dumont sailed from St. Cloud around the Eiffel Tower, and returned within half an hour. Won the "Deutsch Prize." Balloon was 108 feet long, 20 feet diameter and fitted with a gasoline motor of 18-20 H. P. Velocity, nineteen miles per hour. French experiment.
- 1902—Lebaudy Brothers launch non-rigid dirigible "Jaune," attaining a speed of 26 m. p. h. Length, 180 feet, diameter, 32 feet; filled with 80,600 cubic feet hydrogen; fitted with a 40 H. P. Daimler motor, operating twin propellers. Ballonnets used.
- 1904—The "Lebaudy" accepted by French War Department. Same type as the "Jaune."
- 1906—The "Patrie" built. General cigar-shaped form of Renard used. Length was 197 feet, diameter, 33 feet. Fitted with horizontal and vertical stabilizing planes at stern of bag; also a directive rudder at rear of framework. Volume 128,900 cubic feet. Car had exceptionally long suspension, from an elliptical frame-work of steel tubes. Designed by Julliot.
- 1907—October 12. H. E. Gaudron, J. L. Launer and C. C. Turner attempted to break world's record for distance (1,193 miles, held by Count de la Vaulx) Balloon ascended from Crystal Palace, crossed the North Sea, from Yarmouth to north coast of Denmark, a sea-distance of 360 miles. This is largest over-sea voyage made to time of flight. Journey ultimately terminated at shore of Lake Wener in Sweden. Total distance 702 miles.
November 23. The "Patrie" sailed from Chalais to Verdun, 187 miles, in 6 hours and 45 minutes, against a light wind.
- 1908—November. A. E. Gaudron, E. M. Maitland and C. C. Turner make a flight from London, England, to Mateki, Dereveni, Russia—1,117 miles in 31 $\frac{1}{2}$ hours. Longest flight made from England.
The German Government purchases the "Gross I," "Parseval I," and "Zeppelin I."
United States War Department purchases Thomas R. Baldwin's dirigible, 96 x 19 $\frac{1}{2}$ feet, with Curtiss 20 H. P. motor.
- 1909—The non-rigid dirigible "Espana" travels from Beauval to Paris and return in five hours and ten minutes at 31 m. p. h.
- 1910—October 17. A. R. Hawley and Augustus Post travel in "America" from St. Louis to North Lake Chilogoma, Canada, a distance of 1,172.9 miles.
October 26. French build dirigible for English Government.
October 26. The "Morning Post" makes flight from Moisson to Farnborough, a distance of 230 miles, in 5.5 hours. Speed almost 42 m. p. h.
- 1912—October 27. Bienaime and Rumpelmager, start on a journey from Stuttgart to Riazau, Russia, 1,375 miles.
- 1913—June 19-21. Rumpelmager and William Goldschmidt, sail from Lamotte, Brenil to Voitchy, Kharkoff, 1,500 miles.
- 1914—February 8-10. "Berliner" sails from Bitterfeld to Bigsertsk in Peru, 1,895 miles.

MAPPING OF AERIAL ROUTES

IT used to be thought that all the air was a highway; no roads in the ordinary sense were needed; aviators could go as the bird flies, and where they would. Recent events have gone far to dispell this impression. It has been made clear that if there is one thing that is needed for the development of the aeronautical industry, it is aerial roads. Machines need definite routes to follow; routes a feature of which will be landing fields and facilities for repairing and supplying of journeying ships. And it is significant that the first work of the Aviation Service since it has found itself on a peace basis has been the routing of aerial highways for the benefit of United States mail planes, and of the aeronautical industry in general.

Captain Archie Miller of the Division of Military Aeronautics has been supervisor of mapping work which has comprised the projected mapping of 44,058 miles of sky roadways. Over 75% of this has already been accomplished, and by the time this Annual is in the hands of the reader, the entire stint will undoubtedly be finished.

This work covers a large part of the southern half of the United States, running up on the Pacific coast into Oregon and Washington, and on the Atlantic as far as New York City. As soon as warmer weather permits of operations in the northern half of the country, the Government will take up the problem of doing for it what has already been largely accomplished for the southern half.

Many of the separate trips which have gone to make the complete accomplishment have been highly spectacular. The best known is undoubtedly the journey taken by Major Albert F. Smith and his party from San Diego to New York City. This flight, as is known, represented the first journey of aircraft in formation across the continent. It indicated, with the fifty-two hours required to make the trip from San Diego to Washington, that direct travel from coast to coast could be accomplished in less than forty flying hours. It showed that war machines, unadapted as they are to the continuous flying in long periods which mapping requires, can make a creditable showing for themselves, and is suggested that ships especially designed for long periods of travel can probably do work of a distinctly higher quality.

The longest trip actually made under Captain Miller's direction was that from Taliaferro, Fort Worth, Texas, to Oklahoma City, Oklahoma, by way of Gainesville, Ardmore, Paul's Valley, Pursell, etc. This trip covered a total of 3,752 miles.

One of the most spectacular flights made was that of October 1, 1918, from Ellington Field, Houston, Texas, to Denver, Colorado, by Lieutenants C. C. Nutt and R. L. Gruntz. The plane in which they flew was the first to enter Denver. And although the flight of 1,055 miles was not so long as many which have been made, the difficulties under which it was completed make it highly worthy of notice. The terrain over which the two flyers passed was of high altitude, and the air conditions at the 12,000 foot level at which they were forced to fly were very bad. Difficulty was experienced in getting into the air again after landing was made at an altitude of 6,666 feet. Two miles were required for the takeoff.

Another interesting journey was that made from Mather Field, Sacramento, California, to Seattle, Washington, by Lieutenant L. F. Hogland. The aerial journey was made over a distance of 1,365 miles through almost continual snow, sleet, rain and fog. Unable to gain sufficient altitude to cross the Cascades, the flyer was compelled frequently to dodge snow-capped mountain peaks and to clear others by less than one hundred feet. Passing Mount Shasta at a 9,100 foot altitude, he was enveloped in a snow storm. The return journey, however, showed that experience could go far in obviating difficulties of flying over mountainous country.

It was discovered as a result of the total data accumulated from the many trips made that certain difficulties were, in general, apparent in this work of aerial exploration. In the first place, it was found difficult to get satisfactory oil and gas, even when these were telegraphed for in advance. It was discovered that the curiosity of the public interfered greatly with successful landings; crowds persisting in coming upon landing fields and, in some instances, preventing machines from alighting, with disturbing results such as tail spins, etc. The landing fields themselves were often unsatisfactory. Finally, difficulty was experienced, as has already been seen, with flying in high altitudes.

It is of uncommon interest and significance that all these difficulties were of a kind caused by the unprecedented nature of the work. The purpose of the mapping, in general, was to locate landing fields with respect to towns, cities, etc., and to indicate satisfactory routes on which the aviator would find natural landing fields in case of difficulty. In other words, data was being collected for the establishment of stations, and for the location and description of features along the route which would serve the aerial traveler. Granting the establishment of landing and supply fields, we may eliminate practically

all of the difficulties experienced. Proper gas and oil will be forthcoming when regular stations have been established. The public will be controlled; crowds will not interfere with landings or molest machines through curiosity and thoughtlessness. Places selected for landing will be improved so as to make them usable as regularly as possible. The difficulty offered by high altitudes will be overcome to a large extent by a careful selection of routes passing over the lowest possible altitudes and by experience in actual flying in thin air.

The result of the trips is, therefore, in a general way, highly encouraging. It is encouraging, too, because it indicates that successful flights can be made under difficulties over long distances when they are demanded. It shows that it is practicable for the Government to extend the antennae of its Aerial Mail Service into every part of the United States, and the indication is that where aerial mail can go, aerial commerce can follow. Nothing has really been done in the United States or in Europe which matches in the significance of its total performance this series of flights made under the direction of the Department of Military Aeronautics.

ROUTE MAPPING

Trips Made Under Direction of the Division of Military Aeronautics

	Miles
Gerstner Field, Lake Charles, Louisiana—To Eberts Field, Lonoke, Arkansas, via Natchitoches and Minden, Louisiana, and Warren and Pine Bluff, Arkansas, returning via Greenville, Mississippi, and Providence, Harrisonburg and Opelousas, Louisiana	700
Kelly Field, San Antonio, Texas—To El Paso, Texas	720
Kelly Field, San Antonio, Texas—To Laredo, Texas	280
Kelly Field, San Antonio, Texas—To Eagle Pass, Texas	270
Langley Field, Hampton, Virginia—To Emerson Field, Columbia, S. C.	750
Langley Field, Hampton, Virginia—To Wilmington, N. C.	444
Langley Field, Hampton, Virginia—To Salem, Virginia, via Petersburg, Richmond and Lynchburg	400
Langley Field, Hampton, Virginia—To Winchester, Virginia, via Charlottesville and Harrisonburg, Virginia, returning via Bolling Field, Anacostia, D. C.	400
Love Field, Dallas, Texas—To Kelly Field, San Antonio, Texas	500
Love Field, Dallas, Texas—To Gerstner Field, Lake Charles, La.	550
Love Field, Dallas, Texas—To Tulsa, Oklahoma, via McKinney, Sherman, Durant, Atoka, McAlester and Muskogee	500
Love Field, Dallas, Texas—To Taylor Field, Montgomery, Alabama, via Shreveport, Louisiana and Vicksburg, Jackson and Meridian, Mississippi, and Demopolis, Alabama	1,100
March Field, Riverside, California—To Truxton, Arizona	600
March Field, Riverside, California—To Bakersfield, California	220

	Miles
March Field, Riverside, California—To Mather Field, Sacramento, California	800
Mather Field, Sacramento, California—To Red Bluff, California	250
Mather Field, Sacramento, California—To Eureka, California	600
Park Field, Memphis, Tennessee—To Scott Field, Belleville, Ill.	430
Park Field, Memphis, Tennessee—To Eberts Field, Lonoke, Arkansas	250
Park Field, Memphis, Tennessee—To Nashville, Tennessee	420
Barron Field, Ft. Worth, Texas—To Norton, Kansas	1,000
Call Field, Wichita Falls, Texas—To Amarillo, Texas	430
Call Field, Wichita Falls, Texas—To Ft. Smith, Arkansas, via Ft. Sill and Oklahoma City	600
Carlstrom Field, Arcadia, Florida—To Souther Field, Americus, Ga.	650
Chanute Field, Rantoul, Illinois—To Scott Field, Belleville, Ill.	320
Chanute Field, Rantoul, Illinois—To Selfridge Field, Mt. Clemens, Mich.	620
Dorr Field, Arcadia, Florida—To Miami, Florida	225
Dorr Field, Arcadia, Florida—To Ocala, Florida, via Ft. Meade, Bartow, Lakeland, returning via Dade City, Brooksville, Sumterville, Leesburg, Eustis, to Ocala	550
Eberts Field, Lonoke, Arkansas—To Love Field, Dallas, Texas	580
Eberts Field, Lonoke, Arkansas—To Scott Field, Belleville, Illinois, via I. Mt. & S. R. R. to Poplar Bluff, thence via Ireton	570
Eberts Field, Lonoke, Arkansas—To Tulsa, Oklahoma, via Danville, Ft. Smith and Muskogee, following Arkansas River	300
Eberts Field, Lonoke, Arkansas—To Jonesboro, Arkansas, via Dardanelle, Fayetteville, Harrison and Batesville, Arkansas, returning via Wynne, Arkansas	450
Ellington Field, Houston, Texas—To Payne Field, West Point, Mississippi	850
Ellington Field, Houston, Texas—To Little Rock, Arkansas	770
Ellington Field, Houston, Texas—To Detroit, Michigan, via Love Field, Dallas, Texas, Eberts Field, Lonoke, Arkansas, Scott Field, Belleville, Illinois, and Wilbur Wright Field, Fairfield, Ohio	2,600
Ellington Field, Houston, Texas—To Rockwell Field, San Diego, California	1,920
Gerstner Field, Lake Charles, Louisiana—To Kelly Field, San Antonio, Texas	620
Gerstner Field, Lake Charles, Louisiana—To Baton Rouge, La.	240
Gerstner Field, Lake Charles, Louisiana—To New Orleans, La.	320
Park Field, Memphis, Tennessee—To Knoxville, Tennessee, via Chattanooga	600
Park Field, Memphis, Tennessee—To Carthage, Tennessee, via Linden, Columbia and Woodbury, Tennessee, returning via Dresden, Tennessee	500
Payne Field, West Point, Mississippi—To Eberts Field, Lonoke, Arkansas	380
Payne Field, West Point, Mississippi—To Souther Field, Americus, Georgia	570
Payne Field, West Point, Mississippi—To Jackson, Mississippi	260
Payne Field, West Point, Mississippi—To Baton Rouge, Louisiana, via Jackson and Vicksburg	550
Payne Field, West Point, Mississippi—To Gulf Port, Louisiana, via Corinth, New Albany, Winona, Yazoo City, McComb, Mississippi, and Franklinton, Louisiana, returning via Meridian, Mississippi	700
Post Field, Ft. Sill, Oklahoma—To Santa Fe, New Mexico	860

	Miles
Post Field, Ft. Sill, Oklahoma—To Tulsa, Oklahoma, via Oklahoma City	350
Post Field, Ft. Sill, Oklahoma—To Barstow, Texas, via Call Field, Wichita Falls, Texas, Seymour, Haskell, Sweetwater and following Texas	750
Rich Field, Waco, Texas—To Corpus Christi, Texas, via Cameron, Gaddings and Cuero	510
Rich Field, Waco, Texas—To Galveston, Texas	375
Rich Field, Waco, Texas—To Kansas City	1,000
Rockwell Field, San Diego, California—To El Paso, Texas	1,200
Rockwell Field, San Diego, California—To Dorr Field, Arcadia, Florida, via El Paso, Texas	1,800
Rockwell Field, San Diego, California—To The Needles, California	420
Rockwell Field, San Diego, California—To San Francisco, California	1,050
Scott Field, Belleville, Illinois—To Chanute Field, Rantoul, Ill.	320
Scott Field, Belleville, Illinois—To Ft. Leavenworth, Kansas	520
Scott Field, Belleville, Illinois—To Tulsa, Oklahoma, via St. Louis & S. F. R. R.	750
Scott Field, Belleville, Illinois—To Hillsboro, Missouri, via Kansas City, Topeka, Marysville, Belleville, Smith Center, Norton, Colby, Scott, Garden City, Kinsley, Pratt, Kingman, Wichita, Eureka, Iola and Ft. Scott, Kansas, and Clinton, Versailles and Vienna, Missouri	900
Selfridge Field, Mt. Clemens, Michigan—To Chanute Field, Rantoul, Illinois	620
Selfridge Field, Mt. Clemens, Michigan—To Cincinnati, Ohio	400
Souther Field, Americus, Georgia—To Emerson Field, Columbia, S. C.	470
Souther Field, Americus, Georgia—To Taylor Field, Montgomery, Ala.	240
Souther Field, Americus, Georgia—To Savannah, Georgia	344
Souther Field, Americus, Georgia—To Charleston, S. C., via Augusta, Aiken, Bamberg and St. George	550
Souther Field, Americus, Georgia—To Sylvania, Georgia, via Fayetteville, Newman, Rome, Lafayette, Jasper, Athens and Crawfordsville, Virginia,	300
Taliaferro Field, Ft. Worth, Texas—To Barstow, Texas, via Texas & Pacific Railway	720
Taliaferro Field, Ft. Worth, Texas—To Oklahoma City, Oklahoma, via Gainesville, Ardmore, Pauls Valley and Purcell	3,752
Taylor Field, Montgomery, Alabama—To Park Field, Millington, Tenn.	550
Taylor Field, Montgomery, Alabama—To Lafayette, Amiston and Gadsen, Alabama, returning via Birmingham	550
Taylor Field, Montgomery, Alabama—To Mobile, Alabama, via Centerville, Eutaw, Butler and Chatom, returning via Brewton, Andalusia, Ozark and Troy.	450
Taylor Field, Montgomery, Alabama—To Tuscombua, Alabama, via Birmingham, and Jasper, Alabama, returning via Decatur and Cullman, Alabama	3,252
TOTAL MILEAGE	44,058
Additional trip—Rockwell Field, San Diego to New York City	4,500
GRAND TOTAL	48,558



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LANDING FIELDS

THE signing of the armistice on November 11, 1918, found the United States Department of Military Aeronautics developed from a meagre 65 officers and 1,120 men to a total personnel of almost 160,000. Not the least part of this development was the establishment of the 40 flying fields which were used for training officers and men in connection with aviation. With peace, however, the emphasis is being somewhat shifted from the flying field to the landing field. Flying fields were primarily used for instructional purposes. Landing fields will be used to meet the needs of a growing aerial activity which promises to have both military and commercial aspects.

The Government planned 73 flights this winter for the purpose of mapping out aerial routes. One of the objects of this aerial mapping was to locate satisfactory landing fields. A number of cities and towns in the United States have actually petitioned the Government to use land in their limits for the establishment of aerial route stations. Two—Independence, Kansas, and Baton Rouge, La.,—have actually prepared fields which have been utilized. The thirteen others include such cities as Phoenix, Ariz.; Dodge City, Kansas; Great Falls, Mont.; Cincinnati, Ohio, and Albany, N. Y. The landing field is accordingly becoming a matter for very practical consideration.

Perhaps the need for landing fields was brought home to those interested in flying by experience with the New York-Washington and the New York-Chicago aerial mail routes. It was found that flying at a chosen time and flying every day at a definite time were two different things. The latter might mean starting in fog or rain. This necessitated flying low and the pilots did not enjoy dodging wind-mills and scraping houses. It was realized that ultimately any aerial mail route must have a certain number of possible landing fields to make its operation practicable.

The territory over which the New York-Washington mail planes fly is a territory which permits landing at almost any point, provided the day is clear and the pilot is flying at some 3,000 to 6,000 feet altitude.

The New York-Chicago route, as it was first attempted, took flyers over a rough territory. In many cases landings could not have been effected over wide stretches of terrain. The Government has been seeking to remedy this condition, which was one of the reasons why the New York-Chicago route was discontinued. Five landing fields have already been established along the route.

The shadow which commercial aviation has cast before itself has likewise been a factor in the interest in landing fields. Several years ago, Mr. G. Holt Thomas, an English aircraft manufacturer and authority, prophesied a great future for commercial aviation. One of the features making for its success would, he thought, be a series of landing fields along every commercial route at a distance of ten miles apart. Those interested in aerial commerce to-day are urging the need of Government action concerning landing fields. The Curtiss Aeroplane and Motor Corporation early volunteered to co-operate with the Government in the establishment of fields over certain routes. As indicated above, the Government is evidently contemplating some general action on the landing field problem.

Perhaps the need for places where machines can descend will, in one sense, never be so great again as it is now. There is evidence that designers are turning their attention to developing machines which can land almost anywhere. A city lot is Second Assistant Postmaster-General Praeger's ideal. Twin and triple motors will enable machines to repair engine trouble during flight, and the increasing carrying capacity of planes in general will doubtless permit of long extended flights. Indeed, flights of two, three and even four hours are common now with almost any type of two-seated machines.

But in another sense, the need for landing fields promises to grow

indefinitely. Aviation is new. The immediate future will doubtless see thousands of machines where there are now dozens. This enormous aerial activity will need regulation, and undoubtedly one of the first steps toward regulation will be the protection of property and inhabitants from promiscuous aircraft landings. Machines will no more be expected to land according to whim than automobiles are now expected to exceed the speed laws established by State and Municipal authorities.

The distribution of flying fields, which can, of course, be used for landing fields, is at present largely limited to the South and southwestern portions of the country. Even for the South and Southwest, however, there exists no adequate chain of fields to serve as stations for aerial travel. This was demonstrated by the mapping expedition, under command of Major Albert D. Smith, which set out from San Diego on December 4th for a trans-continental flight. One of the greatest difficulties the expedition experienced was with respect to oil and gas. Airplanes require a certain grade of both these fuels. The Smith party not only found long stretches of country upon which they could not land at all, but they found that where it was possible to land it was frequently impossible to get fuel for their machines. Delays and some minor motor trouble were caused by lack of these supplies.

The question naturally arises—how many landing fields will be necessary? Nothing very definite can be said in reply to this. Certainly the minimum number will be one which will result in adequate service to flying machines with respect to supplies, and will, at the same time, act as a safe-guard against the dangers of rough territory by affording places for machines to alight—at least, where places would otherwise not be possible on account of the nature of the country. Mr. Holt Thomas's suggestion that landing fields be established every ten miles is probably an extreme one. It at least has not met the unanimous approval of the British Civil Aerial Transport Committee, which has been investigating the question of landing fields as a part of its general investigation of civil aeronautics. "In undeveloped country," says the committee, "regular chains of landing fields at suitable intervals along aerial routes will be indispensable; and in such countries the consequent expense will be less material in view of the comparative advantages which aircraft will enjoy in competition with other forms of transport." But the Committee does not believe that in general landing fields should be laid out at such short distances apart.

There are, however, great possibilities in Mr. Thomas's suggestions. For the machine, which has an altitude of 2,000 feet or more, can always glide in one direction or another to a field when the maximum distance which it is called upon to cover is five miles.

Another advantage of a chain of fields at brief intervals is that in rain or fog the airplane may be practically signalled along its way from one station to another. Lights, radio, or wireless telephone could assist in such a practice. It was found by the United States Mail Service that experienced flyers could frequently reach a point above a field even in rain or in fog. But they were not sure of the exact location of the station above which they were soaring. Those below could hear the drone of the motor as the machine circled uncertainly above them. An equipment including strong signalling lights, which could penetrate day-light fog, would have solved the difficulty which both flyer and station force were sharing.

What is a good landing field? It is, in one sense, any space of smooth ground large enough to permit landing from any direction. It ought to be from a quarter to a half mile across—and certainly free from trees, stacks, ditches or other airplane obstructions. But the landing field which practical aviation will require in the future will be more than this. It will be a field with the necessary space for landing, with signals displayed on the ground indicating wind direction, with a depot containing supplies of gas, oil and water, with one or more hangars, and with facilities for making adjustments to machines. It will also carry a certain minimum stock of airplane spare parts, etc. It will have flares or other means of illumination for night landings.

Doubtless there will be a government system of such fields or a system embracing both government fields and fields sustained by private enterprise. But there will, doubtless, also be municipal landing fields in addition to those which will be part of regular aerial routes. It is not too much to expect that all towns of respectable size will have landing fields.

There are, also many private landing fields. Some of these belong to companies engaged in aircraft business. Some belong to clubs interested in aviation. Some are the property of private individuals who have "ships" for personal use.

One of the most interesting possibilities is the landing field in the heart of the city. There will be a great loss of time if landing fields for such municipalities as New York and Philadelphia are possible only at the outskirts of these cities. From Belmont Park to the

center of New York is a trip occupying fully 40 minutes. Passengers, whose idea in using the airplane is to save time, will doubtless resent having to make a journey before their real journey can begin. The recent feat of the French Pilot, Jules Vedrines, in landing with his old-fashioned Caudron Biplane on the top of a Paris dry goods store 30 x 12 yards, has opened the world's eyes to the possibility of aerial stations in the heart of large cities. There is, indeed, no reason why the roofs of several buildings can not be connected and an ample space secured for landing. Whether the possibility will become an actuality remains to be seen. It may be that future metropolitan architecture will be influenced significantly by the airplane. Certainly the possibilities for overhead civic flying fields are interesting.

In the meantime, the Manufacturers Aircraft Association is doing all that it can to promote interest in landing fields, and to ascertain in what cases their establishment seems likely and practical. A surprising interest has been evinced by various localities in the establishment of landing fields. As the possibilities of commercial aviation become more apparent, existing enthusiasm will doubtless grow. The landing field question is one which, from now on, will be vital to all types of aeronautical activity.



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The Sea Bird Flies Home

AIR SERVICE STATIONS

Flying Fields	ACTIVE	Commanding Officers
Barron Field, Everman, Texas		*Lt. Col. Thomas C. Turner (Major John B. Brooks to assume command)
Carlstrom Field, Arcadia, Fla.		*Major Horace M. Hickam (Lt. Col. Thomas Duncan to assume command)
Ellington Field, Houston, Texas		Lt. Col. Ina A. Rader (Col. Gerald C. Brant to assume command)
Emerson Field, Columbia, S. C.		Major Norman W. Peek
Kelly Field, San Antonio, Tex.		Col. Henry C. Pratt
Love Field, Dallas, Texas		Major Albert L. Sneed
March Field, Riverside, Calif.		Major John P. C. Bartholf
Park Field, Millington, Tenn.		Major John W. Simons, Jr.
Post Field, Fort Sill, Okla.		Lt. Col. Richard B. Barnitz
Rockwell Field, San Diego, Calif.		Lt. Col. H. B. S. Burwell

INACTIVE

Bolling Field, Anacostia, D. C.	Lt. Col. Ralph Hartz
Brooks Field, San Antonio, Texas	*Major John B. Brooks
Call Field, Wichita Falls, Texas	Major James R. Alfonte
Carruthers Field, Benbrook, Texas	*Lt. Col. Jacob E. Fickel
Chanute Field, Rantoul, Ill.	Lt. Col. Ira Longanecker
Chapman Field, Miami, Florida	Major Jacob H. Rudolph
Dorr Field, Arcadia, Fla.	*Major Horace M. Hickam
Eberts Field, Lonoke, Arkansas	*Lt. Col. Thomas Duncan
Gerstner Field, Lake Charles, La.	Lt. Col. William C. McChord
Mather Field, Sacramento, Calif.	Lt. Col. Henry L. Watson
Payne Field, West Point, Miss.	Major Ralph Cousins
Rich Field, Waco, Texas	Major John G. Whitesides
Selfridge Field, Mt. Clemens, Mich.	*Major Frank D. Lackland
Scott Field, Belleville, Ill.	Major Henry Abbey
Souther Field, Americus, Ga.	Lt. Col. Frederick T. Dickman
Taliaferro Field, Hicks, Texas	Major Theodore C. McCauley
Taylor Field, Montgomery, Ala.	Lt. Col. Seth W. Cook
Camp Dick (Cadet Gunnery Camp), Dallas, Texas	1st Lt. Albert S. Cumins
Langley Field, Hampton, Va.	Major Clinton W. Howard (Major Frank D. Lackland to assume command)
Wilbur Wright (Armorers' School), Fairfield, Ohio	Lt. Col. Henry C. K. Muhlenber

PROVISIONAL WINGS

INACTIVE

First Provisional Wing, Hazelhurst, L. I.	Lt. Col. Millard F. Harmon, Jr.
Brindley Field, Commack, L. I.	*Major H. H. C. Richards
Henry J. Damm Field, Babylon, L. I.	Major E. Lyons
Hazelhurst Field, Mineola, L. I.	*Major J. J. O'Connell
Lufbery Field, Wautaugh, L. I.	1st Lt. W. S. Maurice
Mitchel Field, Mineola, L. I.	Major H. M. Clark

* Ordered from.

Flying Fields	Commanding Officers
Roosevelt Field, Mineola, L. I.	Major Henry J. F. Miller
Second Provisional Wing, Park Place, Houston, Texas	Major Roy S. Brown

MISCELLANEOUS STATIONS

Proving Ground, Active, Aberdeen, Md. . .	Major Adlai H. Gilkeson
• Camp Alfred Vail, Inactive, Little Silver, N.J.	Colonel C. W. Helms
Ford Field, Active, Oahu, Hawaiian Ter. . .	Captain Hugh J. Knerr
France Field, Active, Panama Canal Zone . .	Major Loring Pickering

GROUND SCHOOLS

SCHOOLS OF MILITARY AERONAUTICS

University of California, Berkeley, Calif. . . .	Major Chas. B. Crane
Cornell University, Ithaca, N. Y.	*Major Harral Mulliken
University of Illinois, Urbana, Ill.	*Capt. Frank C. Hendry
University of Texas, Austin, Texas	Capt. Herbert G. Knight

BALLOON SCHOOLS

Army Balloon School, Ft. Omaha, Neb. . . .	Lt. Col. Jacob W. S. Wuest
Army Balloon School, Lee Hall, Va.	Major Henry R. Vaughan
Army Balloon School, Arcadia, Calif.	Lt. Col. Leonard J. Mygatt
Camp John Wise, San Antonio, Texas	Lt. Col. D. H. Bowen
29th Balloon Company, Ft. Monroe, Va. . . .	Capt. Ross G. Hoyt
Balloon Detachment, Ft. Sill, Okla	Major F. M. Kennedy
Balloon Detachment, Langley Field, Va. . . .	1st Lt. Chas. W. White
32d Balloon Company, Camp McClellan, Ala.	Lt. William Turnbull
31st Balloon Company, thru Commanding Officer, Godman Field, Camp Knox, Stith-ton, Ky.	Capt. Arthur Thomas
33d Balloon Company, Camp Jackson, Columbia, S. C.	1st Lt. A. J. Gorman
28th Balloon Company, thru Commanding Officer, Aberdeen Proving Ground, Aberdeen, Md.	1st Lt. Gail H. McMillin

ARMY BALLOON INSPECTION

Officer in charge of Airship, Training and Construction, Akron, Ohio	Lt. Col. William N. Hensley (To assume command)
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RADIO SCHOOLS

Air Service School for Radio Officers: Columbia University, New York	Major Rodman Gilder
Air Service School for Radio Officers: Operators—Penn Field, Austin, Texas	Capt. Byron H. Mills
Air Service School for Radio Officers: Mechanics—Carnegie Institute of Technology, Pittsburgh, Pa.	Capt. John H. Alden
Air Service Radio Officer, thru Commandant, Field Artillery, Brigade Firing Center Camp McClellan, Anniston, Ala.	

* Ordered from.

AIR TRAINING RADIO WAREHOUSE

Flying Fields	Commanding Officers
Houston, Texas	1st Lt. Harvey N. Pyr

FIRING CENTERS

	Location
Commanding Officer, Military Aeronautics, Emerson Field, Field Artillery Replacement Depot	Camp Jackson, Columbia, S. C.
Commanding Officer, Military Aeronautics, Field Artillery, Brigade Firing Center	Camp Doniphan, Ft. Sill., Okla.
Commanding Officer, Military Aeronautics, Godman Field, thru Commandant, Field Artillery, Brigade Firing Center	Camp Knox, Stithton, Ky.

PHOTOGRAPHIC SCHOOLS

	Commanding Officers
U. S. School of Aerial Photography, Inactive, Rochester, N. Y.	1st Lt. William V. Andrews
Photographic School, Cornell University, Ithaca, N. Y.	1st Lt. William Wheeler
Preliminary Photographic School, Ft. Ethan Allen, Burlington, Vt.	1st Lt. R. E. Sands

MECHANICS SCHOOLS

Air Service Mechanics School, Kelly Field, South San Antonio, Texas	Major George E. Stratemeyer
†Air Service Mechanics School, Inactive, Overland Building, St. Paul, Minn.	Capt. John Ryan (Officer in charge)
Air Service Recruit Receiving Depot, Ft. Wayne, Mich.	Major Howard L. Campion

AVIATION GENERAL SUPPLY DEPOTS

Americus, Ga.	Major E. S. Schofield
Houston, Texas	Capt. J. C. Tipps
Middletown, Pa.	Major William H. Garrison, Jr.
Richmond, Va. (Balloon)	Capt. Chas. W. Stolze
San Antonio, Texas	Major George F. Brett
Los Angeles, Calif.	Capt. Chas. Payne
Little Rock, Ark.	Major George H. Eichelberger (Lt. Col. Geo. W. D'Armond to assume command)
Washington, D. C.	1st Lt. J. E. Menrath
Buffalo, N. Y.	Capt. C. H. Vanderpool
Detroit, Mich.	Major F. C. Bahr
Dayton, Ohio	Capt. James P. Caffery, A. S. A.

AIR SERVICE DEPOTS

Garden City, L. I., N. Y.	Lt. Col. H. W. Gregg
Morrison, Va.	Major V. H. Dumas
Wilbur Wright Air Service Depot, Fairfield, Ohio	Lt. Col. Henry C. K. Muhlenberg

† Discontinued training preparatory to being closed.

PORTS OF EMBARKATION

Flying Fields	Commanding Officers
New York, N. Y.	Capt. Jarvis S. McCrea
Newport News, Va.	2d Lt. E. J. Flood
Philadelphia, Pa.	Lt. C. A. Ditty
Baltimore, Md., Coca Cola Building	1st Lt. J. B. Shober

AVIATION REPAIR DEPOTS

Indianapolis, Ind.	Major Patrick Frissell
Dallas, Texas—A. R. D.	Lt. Col. D. B. Netherwood
Montgomery, Ala.	Major Louis R. Knight

COMPASS POINTS AND THEIR EQUIVALENTS

° /	POINTS	° /	POINTS	° /	POINTS	° /	POINTS
0 00	N	90 00	E	180 00	S	270 00	W
2 49	N $\frac{1}{4}$ E	92 49	E $\frac{1}{4}$ S	182 49	S $\frac{1}{4}$ W	272 49	W $\frac{1}{4}$ N
5 38	N $\frac{1}{2}$ E	95 38	E $\frac{1}{2}$ S	185 38	S $\frac{1}{2}$ W	275 38	W $\frac{1}{2}$ N
8 26	N $\frac{3}{4}$ E	98 26	E $\frac{3}{4}$ S	188 26	S $\frac{3}{4}$ W	278 26	W $\frac{3}{4}$ N
11 15	N by E	101 15	E by S	191 15	S by W	281 15	W by N
14 04	N by E $\frac{1}{4}$ E	104 04	ESE $\frac{1}{4}$ E	194 04	S by W $\frac{1}{4}$ W	284 04	WNW $\frac{3}{4}$ W
16 53	N by E $\frac{1}{2}$ E	106 53	ESE $\frac{1}{2}$ E	196 53	S by W $\frac{1}{2}$ W	286 53	WNW $\frac{1}{2}$ W
19 41	N by E $\frac{3}{4}$ E	109 41	ESE $\frac{3}{4}$ E	199 41	S by W $\frac{3}{4}$ W	289 41	WNW $\frac{1}{4}$ W
22 30	NNE	112 30	ESE	202 30	SSW	292 30	WNW
25 19	NNE $\frac{1}{4}$ E	115 19	SE by E $\frac{3}{4}$ E	205 19	SSW $\frac{1}{4}$ W	295 19	NW by W $\frac{3}{4}$ W
28 08	NNE $\frac{1}{2}$ E	118 08	SE by E $\frac{1}{2}$ E	208 08	SSW $\frac{1}{2}$ W	298 08	NW by W $\frac{1}{2}$ W
30 56	NNE $\frac{3}{4}$ E	120 56	SE by E $\frac{1}{4}$ E	210 56	SSW $\frac{3}{4}$ W	300 56	NW by W $\frac{1}{4}$ W
33 45	NE by N	123 45	SE by E	213 45	SW by S	303 45	NW by W
36 34	NE $\frac{1}{4}$ N	126 34	SE $\frac{3}{4}$ E	216 34	SW $\frac{3}{4}$ S	306 34	NW $\frac{3}{4}$ W
39 23	NE $\frac{1}{2}$ N	129 23	SE $\frac{1}{2}$ E	219 23	SW $\frac{1}{2}$ S	309 23	NW $\frac{1}{2}$ W
42 11	NE $\frac{3}{4}$ N	132 11	SE $\frac{1}{4}$ E	222 11	SW $\frac{1}{4}$ S	312 11	NW $\frac{1}{4}$ W
45 00	NE	135 00	SE	225 00	SW	315 00	NW
47 49	NE $\frac{1}{4}$ E	137 49	SE $\frac{1}{4}$ S	227 49	SW $\frac{1}{4}$ W	317 49	NW $\frac{1}{4}$ N
50 38	NE $\frac{1}{2}$ E	140 38	SE $\frac{1}{2}$ S	230 38	SW $\frac{1}{2}$ W	320 38	NW $\frac{1}{2}$ N
53 26	NE $\frac{3}{4}$ E	143 26	SE $\frac{3}{4}$ S	233 26	SW $\frac{3}{4}$ W	323 26	NW $\frac{3}{4}$ N
56 15	NE by E	146 15	SE by S	236 15	SW by W	326 15	NW by N
59 04	NE by E $\frac{1}{4}$ E	149 04	SSE $\frac{3}{4}$ E	239 04	SW by W $\frac{1}{4}$ W	329 04	NNW $\frac{3}{4}$ W
61 53	NE by E $\frac{1}{2}$ E	151 53	SSE $\frac{1}{2}$ E	241 53	SW by W $\frac{1}{2}$ W	331 53	NNW $\frac{1}{2}$ W
64 41	NE by E $\frac{3}{4}$ E	154 41	SSE $\frac{1}{4}$ E	244 41	SW by W $\frac{3}{4}$ W	334 41	NNW $\frac{1}{4}$ W
67 30	ENE	157 30	SSE	247 30	WSW	337 30	NNW
70 19	ENE $\frac{1}{4}$ E	160 19	S by E $\frac{3}{4}$ E	250 19	WSW $\frac{1}{4}$ W	340 19	N by W $\frac{3}{4}$ W
73 08	ENE $\frac{1}{2}$ E	163 08	S by E $\frac{1}{2}$ E	253 08	WSW $\frac{1}{2}$ W	343 08	N by W $\frac{1}{2}$ W
75 56	ENE $\frac{3}{4}$ E	165 56	S by E $\frac{1}{4}$ E	255 56	WSW $\frac{3}{4}$ W	345 56	N by W $\frac{1}{4}$ W
78 45	E by N	168 45	S by E	258 45	W by S	348 45	N by W
81 34	E $\frac{1}{4}$ N	171 34	S $\frac{3}{4}$ E	261 34	W $\frac{3}{4}$ S	351 34	N $\frac{3}{4}$ W
84 23	E $\frac{1}{2}$ N	174 23	S $\frac{1}{2}$ E	264 23	W $\frac{1}{2}$ S	354 23	N $\frac{1}{2}$ W
87 11	E $\frac{3}{4}$ N	177 11	S $\frac{1}{4}$ E	267 11	W $\frac{1}{4}$ S	357 11	N $\frac{1}{4}$ W



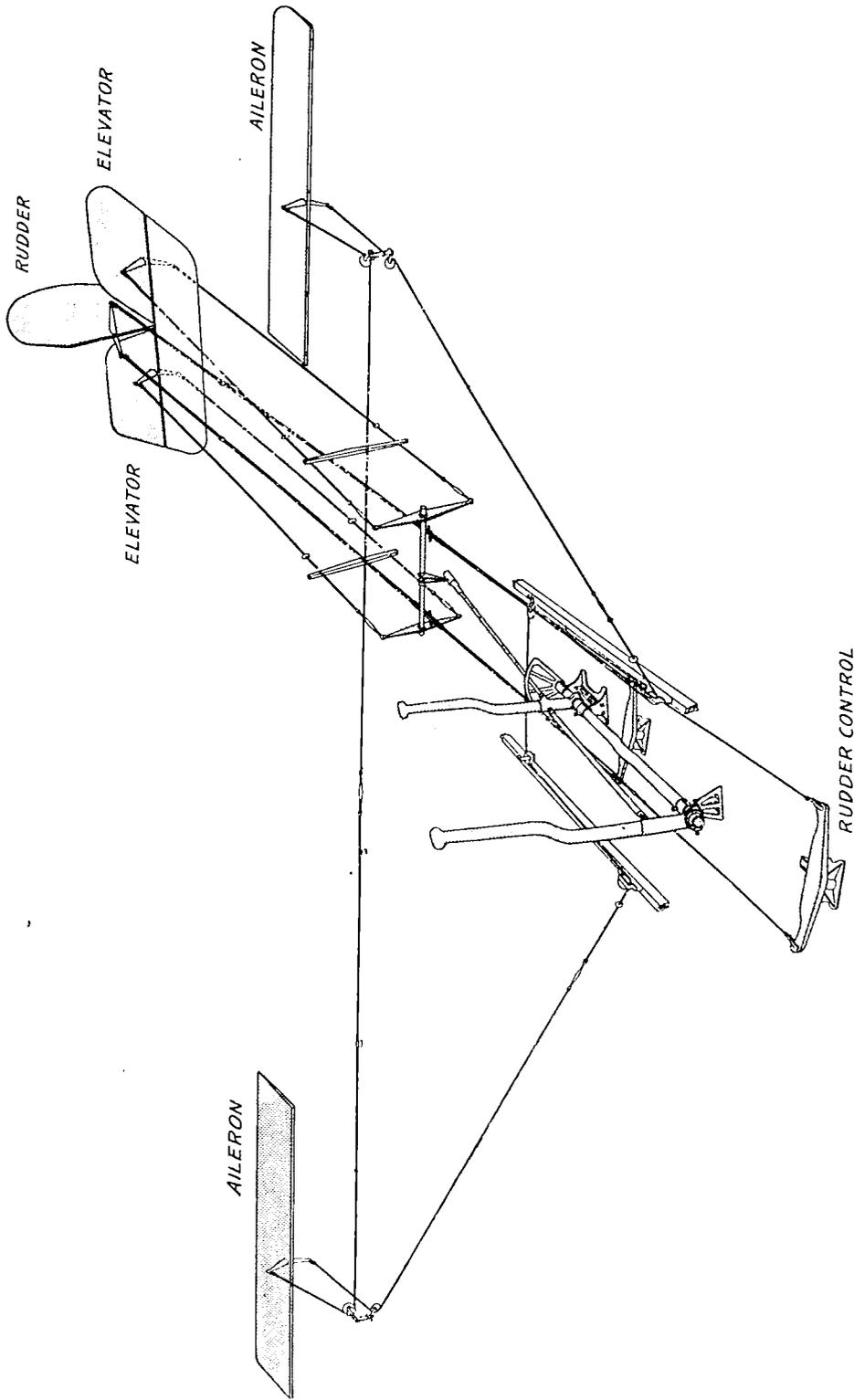
HOW MEN FLY

“I DON'T see how the thing does it!” This exclamation could have been heard six months ago at any one of the forty flying fields throughout the United States as cadets and officers gathered around some tiny Scout type of airplane. The wing spread of the machine we may imagine them viewing is probably twenty-two feet. But part of this is over the “ship's” body; the wings extend clear on either side no more than eight or nine feet. And they look only five or six. How can a squat, heavy-looking contrivance like that carry engine, guns, pilot, and itself to an altitude of 8,000 feet in 10 minutes?

It is the extreme phrasing of the question, “How can men fly?” And the answer is, “Men can fly because there are natural laws which permit of their doing so, and because they have by long experiment and practice learned to use these laws.”

Anything heavier than air will be attracted by gravity, if some means for its sustentation are not supplied. In an airplane, the designer considers the forward velocity and the cross-sectional shape of the supporting surfaces, as the two agencies that permit flight. He plans to build a heavier-than-air machine, but he wishes to limit weight so as to increase velocity. And the spruce, linen, ash, wire, etc., of which the body and wings of an airplane are constructed are comparatively light. But they are heavy enough, and a mahogany propeller and an engine weighing from 300 to 600 pounds will make the entire machine one of considerable weight.

There are two elements on which the designer relies to raise his craft and to maintain it in flight. One is the shape of its surfaces. By



RUDDER CONTROL

A diagrammatic sketch of a standard Dual Stick Control System

watching birds and fishes inventors guessed long ago that any medium was sensitive to the shape of the thing passing through it. Experiments in "wind tunnels" enabled them to measure the resistance the air gave to various shapes, and they found that the atmosphere had imperial preferences. It abhorred a square as Nature in general is said to abhor a vacuum. It did not make way with surprising readiness for a sphere. But a shape like that of a pear, moving head first, found its passage a comparatively easy one.

The modern airplane utilizes what had been discovered; its body is fish-like in contour. Its struts, or wooden braces, are shaped to cause the least disturbance possible from the stream of air passing by them; they are "streamlined." Even the wires of some machines have a pear-like cross-sectional shape. And the wings, of course, have been carefully constructed with regard to the behavior of the air through which they pass.

What, indeed, of the wings? We have suggested the negative aspect of flying design; what about its positive side?

It may be introduced with this: a flat arched surface like an airplane wing gets not only resistance as it passes through the air, but a certain amount of help. The air packs beneath its lower surface, and at the foremost part of the upper surface it forms a partial vacuum owing to the speed with which the plane passes through it. The packing pushes up, the vacuum permits and encourages upward movement; the combined result is "lift." And "lift" is the great factor in flying. It is the positive force. Embattled against it is a combination of the pull of gravity, "drift," the hurtful or retarding effects of air resistance, and "skin-friction" and "deadhead resistance" of other parts of the machine than the wings. The wings must have enough "lift" to carry everything, themselves included.

As has been indicated, they get much of their lift from their own shape. But that is merely passive. It is what will work *when* the wing is passed through the air. But what is to do the passing?

This is the question which puzzled men for centuries. The human body was not remotely adequate to the task. Everything that could furnish the means of speed was too heavy. It was not until the light gas engine had been developed that a form of propulsion adaptable to flying was found. To-day it is the scientifically streamlined body and braceage, the delicately shaped wing, and the light, but powerful motor which unite to keep the airplane aloft. So accurately have all of these been developed that their triumph seems a cheat, a mystery. But it is no more than a skillful adaptation to clearly defined, natural laws.

But granting that the wings will be given adequate speed by a motor, and that their shape will then allow the development of sufficient lifting power to keep themselves and what is attached to them afloat, there is still no achievement of genuine flight. For flight means control, and wings and motor alone cannot give that.

Control—stability of the machine and the ability to direct its movements—was long a stumbling block to aerial success. “To contrive is nothing, to construct is something, to operate is everything,” said Lilienthal. He was wrong in one sense; good design should come first. But he was right in realizing that control, however it came, must be present. It was their ability to control the airplane which made the Wright Brothers the first successful flyers.

How is control achieved? First of all, by balancing a machine properly. Every machine has a center of gravity, of course, and swings from side to side or up or down on invisible axes running through it. Many early machines lacked longitudinal stability; they upset themselves by rearing up or pitching downward. Some, and indeed almost all in windy weather, were apt to manifest lateral instability also. The first machine flown by Santos-Dumont rocked and cavorted about like a playful kitten. And in addition, there was a need for what is called directional stability—the ability of the machine to keep to the direction in which it was pointed.

What has been done to overcome these difficulties is what Nature has done for fish and birds. The fish has a tail and fins. His whole body gives him directional stability, but he has his tail and the fins on the top of his back to assist the body. The airplane uses what is called a vertical fin for this purpose—it is set at the tail of the machine against the rudder, which is hinged to it. Sometimes this type of stability is increased by “sweep-back,” a process which changes the angle at which the wings are set with respect to the body from a right angle to an acute one. In other words, the wings form a wide “V,” the base pointing forward, and the body or fuselage running backward from it.

Longitudinal stability is encouraged by the “horizontal stabilizers,” fixed planes sprouting sideways like little wings at the tail. The rudder is set between them, and the elevators are attached to them, are indeed in a neutral position, mere continuations. These horizontal stabilizers are so set as to lift when the tail sinks and push down when it rises, during flight. But they only give a tendency toward longitudinal stability; the elevators do the decisive work.

“Dihedral” and “keel surface” give lateral stability. They are

devices making for automatic return to normal position. Dihedral makes a "V" of the wings up and down, very slight, but perceptible in many machines. When the machine starts to fall to one side the wing on that side must pass through a horizontal position, and when it is in this position the other wing is tilted up slightly. The first wing exposes more surface to the air, and hence gets more lift, so that the tendency is for it to rise until the machine is again in a normal position. The action of keel surface is too complicated to be discussed here.

All these features are ones which make for "inherent stability." They can be accentuated until the machine will be almost impossible to upset. But it has been found more satisfactory to have them to a moderate degree only. Better results are obtained by relying mostly on positive controlling surfaces. And they are the ailerons and the rudder and the elevators.

Here we have the fins and tail of the fish. The ailerons are set in the wings at the outer, rear corners: they are jointed and move up and down, the aileron in one wing moving in the opposite direction from the other. If one wing is low, and the pilot wishes to raise it, he lowers the aileron on that side. Now this gives a greater angle of incidence to that wing, and by forcing the opposite aileron up, gives a lesser angle of incidence to the other. The angle of incidence is the angle at which the plane is slanted from the path of flight, and up to a certain point the greater the angle the greater will be the resultant "lift." Naturally the wing whose aileron goes down gets this lift, as the other wing has had its aileron practically removed, indeed, when an aileron goes up it is not only not opposed to wind from beneath, but is pushed at by wind from above, which tries to force it down. So the wing whose aileron was lowered swings up, and the machine is in normal position. Usually, however, the aileron is used in a "bank," and then the pilot wants his wing down. Turning the tail by moving the rudder, he swings the head of the machine around the turn by means of his ailerons. Ailerons and rudder moved together make a "Bank." They are "put on" to get the machine set for the turn, pulled back to a neutral position while the turn is being made, and then thrown in the opposite direction to get the "ship" into a level position again.

The rudder, as has just been suggested, is the positive directional control, and swings the tail of the machine as a ship's rudder or a fish's tail moves vessel or fish. The elevators are the positive longitudinal control. They raise the tail if lowered, lower it if raised. They thus alter the angle of incidence for the wings of the machine, sending the

aircraft upward or downward according as the "lift" varies with the degree at which the sails of the "ship" are set to the rush of air.

How can the pilot manage all these things at once? Their manipulation is rather simple. His feet rest on a rudder bar, which is not unlike the front of a flexible coaster. A shove with his right foot gives "right rudder," that is, turns the machine toward the right. A movement of the left foot produces the opposite effect. Between his knees rises a "stick" much resembling a very thick hoe handle. If he moves this to the side he moves an aileron; backward or forward, an elevator. A diagonal movement controls both. The pilot soon moves stick and rudder together automatically. Sometimes he has a wheel to move instead of the stick, the wheel being set on a "bridge" or framework which must be moved backward or forward to operate the elevators. The ailerons require movement of the wheel on its axis without movement of the bridge.

Airplane control is facilitated by the fact that a movement of the lever forward means a going forward, i. e., downward, a back pull means an angle of ascent. A movement of the stick to the right means a dipping of the right wing—necessary for a right turn. Direction and purpose, in other words, agree. While, in a sense, the operation is, as Lilienthal said, everything, the design has made it easy to master. The once astonished spectator, having become a performer, forgets that he ever wondered how men could fly.

ALTITUDE RECORDS

Feet	Aviator	Aeroplane	Place	Date
645	-Rougier	.....	Brescia, Italy	Oct. 1909
1,300	Lambert	.....	Juvisy Aerodrome near Paris, Fr.	Oct. 18, 1909
1,960	Paulhan	Farman	.....	Nov. 20, 1909
3,445	Latham	Antoinette	Betheny Plain	Jan. 7, 1910
4,165	Paulhan	Farman	Los Angeles	Jan. 12, 1910
4,541	Latham	Antoinette	Rheims	July 7, 1910
6,175	Brookins	Wright	Atlantic City	July 9, 1910
6,604	Drexel	Bleriot	Lanark, Sc.	Aug. 11, 1910
8,271	Morane	Bleriot	Havre, France	Sept. 3, 1910
8,406	Chavez	Bleriot	Issy	Sept. 8, 1910
9,104	Wijnmalen	Farman	Mourmelon	Oct. 1, 1910
9,714	Johnstone	Wright	Belmont Park	Oct. 31, 1910
10,499	Leganeaux	Bleriot	Pau	Dec. 9, 1910
11,474	Hoxey	Wright	Los Angeles	Dec. 26, 1910
16,068	Garros	.....	Houlgate, France	Sept. 6, 1912
20,172	Legagneux	.....	St. Raphael, Fr.	Dec. 27, 1913
26,246	Oelrich	.....	Lindenthal, Ger.	July 14, 1914
28,900	Schroeder	.....	Dayton, Ohio	Sept. 18, 1918
30,500	Lang	.....	England	Jan. 2, 1919

DESIGNATION OF AEROPLANES

SIMILAR to the system used in designating various models of automobiles and motors in a series, the designation of aeroplanes is based on name, number, letter or other combinations. With the rapid development of the art, the enormous impetus gained during the war, and the complexity and fine distinction in function due to specialization, the system of names and designations has correspondingly expanded. Certain definite terms have been developed:

(1) Single-seater, fast flying machines, speed range about 110–135 miles per hour; weight, about 1600–2000 lbs.; equipped with one or more fixed or adjustable guns; are called “speed scouts.” These engaged in single combat; special duty, including trench-strafting or squadron flights. Machines characteristic of this type are the Nieuport, Spad, SE. 5, Albatross “D.”

(2) Two-seaters, high speed of about 100–120 miles per hour; weight, about 2700–3500 lbs.; equipped with fixed and flexible guns; often also with telegraphic and photographic apparatus were termed “combat machines.” This type generally flew in squadrons, convoying machines of other function; or on offensive and defensive patrol (known in the vernacular of the airmen as “O-pip” and “D-pip” work—“pip” being the designation of the letter “P”).

(3) “Reconnaissance machines”—two-seater type—average high speed of 100 miles per hour; weight, about 3000–3700 lbs.; equipped with photographic and telegraphic apparatus, flares, etc., function as aerial observers. Armed for defensive work only.

(4) “Bombers.” Heavy, large load-carrying machines, often attaining large dimensions. This type ordinarily carried a large consignment of bombs and, flying in squadrons, set out for a definite objective. They were armed for defensive work. Average speed, 90–100 miles per hour, and weight ranging from 4500 to 10,000 lbs.

(5) Training planes of various classes. Used to prepare combat pilots and observers.

The various names by which aeroplanes are recognized to-day fall into six general classes:

- (1) Name of firm, inventor or otherwise.
- (2) Letters of firm.
- (3) Class designation.
- (4) Serial designation.
- (5) Number designation.
- (6) Combination of above.

(1) The early models were generally known by the name of the firm or inventor; particularly the first model produced, as the "Wright." When a machine, even of the later type, demonstrated its superiority in functioning in its particular class, reference to it is frequently made by the name only, as "Handley-Page," "Gotha," "Bristol," "Spad," "Nieuport," "Rumpler," "Roland," etc. In this latter case, the official designation, however, is given generally by some more complex combination. Thus the well-known "Spad" is recorded by the makers as Spad S. VII. Early models often carried fantastic names: Santos Dumont's "Demoiselle" (an Antoinette machine); Curtiss's "June Bug," "Red Wing," "America." This characterization was revived in recent times when the British rechristened the German bombers as "Fritz," and entire squadrons as "circuses."

(2) The letters of firms, either the first initials of the proper names, or a complete combination, is a frequent method of reference. Thus the A. V. Roe machine is officially known as the "Avro." The Germans have abbreviated the extremely long names generally to a concise formula of three letters: Deutsches Flugzeug Werke, "D. F. W."; Allgemeines Electricitäts Gesellschaft, "A. E. G."; Aerowerke Gustav Otto, "A. G. O." (making a complete trade name of the letters); Luft Verkehrs Gesellschaft, "L. V. G."; Luftfahrzeug Gesellschaft, "L. F. G. (Roland)". The French have similarly readjusted a long name: Société Pour Aviation et ses Dérivés to "S. P. A. D."—or more commonly "Spad"; Robert Esnault-Pelteire, "R. E. P." The British similarly call a DeHaviland the "D. H."; All British Motor Co., "A. B. C."; New Engine Co., "N. E. C." This system is the source of the name of the American machine "L. W. F." from "Lowe, Willard, Fowler Co.". The Italian machine "S. I. A." is named from the firm "Società Italiana Aeroplani."

(3) The Germans have utilized the functioning of a machine as another means for designation:

"C" class, for two-man combat machine.

"D" class, for scout machines.

"G" class, for bombing (from "Grossflugzeug").

Thus Albatross may be known as Albatross CI or CII or CIII; again Albatross DI or DII; depending on the function for which it was designed.

The British have developed a series of machines, the designation of which properly falls under this classification: S. E. for "Scout

Experimental". Thus the series runs from S. E. 1 to S. E. 5-A.—the last of which has attained considerable success.

The designations of the British developments from foreign models were also abbreviated to two letters, and as such are known as a class: "Farman Experimental", F. E.; "Bleriot Experimental", B. E. These were later modified by additional characters to indicate the order in which they were developed.

In American practice we have the Thomas-Morse "S" type for Scout Training; Curtiss "S" type for Scouts, etc., etc.

(4) The serial method is one of the commonest used, particularly in connection with other designations. A common method is the use of the letters in the alphabet, either singly or in combination to denote a dual development or merging of the design of two machines. Most known in this class is the Curtiss "JN-4" machine, being a combined development of the characteristics of the "J" and "N" models. The Curtiss "R" and Standard "J" types were named from successive letters of the alphabet. The refinements of a generally accepted model are frequently indicated by letters of the alphabet, as S. E. 5-A—the "A" indicating a development from the S. E. 5, yet having all the external appearances of the S. E. 5. Similarly we have the B. E. 2-a, B. E. 2-b, B. E. 2-c, etc.; JN-4, JN-4A -B, -C, -D, etc. The letter selected will at times show the nature of the machines independent of its class function; thus Curtiss Models "H" are flying boats—numbered consecutively to indicate various developments. The letter H is frequently combined with the standard designation to indicate the motor equipment: thus JN-4H is a standard JN-4 machine fitted with a Hispano-Suiza motor.

(5) The number system is almost universal in its application to all models. It is the most natural and convenient method of indicating the development of machines of either the same or different designs: thus the British F. E. and B. E. derivatives are numerically numbered F.E. 1; F.E. 2 to F.E. 8 inclusive; B.E. 1; B.E. 2; S.E. 1 to S.E. 5, inclusive; Albatross CI to CV, etc., to denote successive products from the basic models. In this manner Curtiss have designated the JN-1 to JN-4, inclusive; R-1 to R-9, inclusive; H-4 to H-12, inclusive, etc.; the Standard J-1; Thomas-Morse S-4, etc.

(6) The combination of the basic systems is obvious from the previous illustrations. Thus, in the final analysis of the machine designation, either the maker, the function, or the order of development may be ascertained.

The following is a summary of the common abbreviations:

BRITISH

- | | |
|------------------------------------|---------------------------------|
| R. A. F.—Royal Aircraft Factory. | S. E.—Scout Experimental. |
| B. E.—Bleriot Experimental. | A. W.—Armstrong Withworth. |
| F. E.—Farman Experimental. | A. B. C.—All British Motors Co. |
| R. E.—Reconnaissance Experimental. | N. E. C.—New Engine Co. |

GERMAN

- | | |
|-----------------------------------------------------|-------------------------------------------------|
| A. G. O.—Aerowerke Gustav Otto. | L. V. G.—Luft Verkehrs Gesellschaft. |
| D. F. W.—Deutsche Flugzeug Werke. | “C” Class—Two-man combat-machine |
| F. F.—Flugzeugbau Friedrichshafen. | “D” Class—One-man scout machine. |
| L. F. G.—Luftfahrzeug Gesellschaft. | “G” Class—Bombing machine (Gross-
flugzeug). |
| A. E. G.—Allgemeines Electricitäts
Gesellschaft. | |

FRENCH

- | | |
|-----------------------------------------------|--------------------------------------|
| Spad—Société Pour Aviation et ses
Dérivés. | F. B. A.—Franco-British Aviation Co. |
| M. F.—Maurice Farman. | R. E. P.—Robert Esnault-Pelterie. |

ITALIAN

- | | |
|--------------------------------------|----------------------------------|
| S. I. A.—Società Italiana Aeroplani. | FIAT—Fabrica Italiana Automobili |
| I. F.—Issota Fracchini. | Turino. |

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- 3 BARBER, CAPTAIN H.—"The Aeroplane Speaks." Robert M. McBride & Co., N. Y., 1917.
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"Aerial Age" (weekly)	280 Madison Ave., New York, N. Y.
"Air Service Journal" (weekly)	120 West 32d St., New York, N. Y.
"Air Power" (monthly)	280 Madison Ave., New York, N. Y.
"Aviation" (semi-monthly)	120 West 32d St., New York, N. Y.
"Flying" (monthly)	280 Madison Ave., New York, N. Y.

BRITISH

"The Aeroplane" (weekly)	166 Piccadilly, London
"Aeronautics" (weekly)	6-8 Bouverie St., London, W.C
"Flight" (weekly)	44 St. Martin's Lane, London, W. C.
"Flying" (weekly)—Published by Land & Water	London

DANISH

"Motor" (weekly)	Vimmelskaftt, Copenhagen, Denmark
"Kratos"	Gutenberghus, Copenhagen, Denmark

DUTCH

"Avia" (semi-monthly)	Wynbrugstraat 13, Rotterdam
"Het Vlieveld" (monthly)	Amsterdam

FRENCH

"L'Aerophile" (monthly)	35 Rue Francois I ^e (Premier) Paris
"L'Aero"	Paris, France
"L'Aviation"	Paris, France
"Le Ballon"	Paris, France
"La Guerre Aerienne"	30 Rue de Provence, Paris, France
"Bulletin du Federation Aeronautique Internationale"	Paris, France

GERMAN

"Deutscher Luftfahrer Zeitschrift"	Nollendorfplatz 3, Berlin
"Flugsport" (monthly)	Bahnhofplatz 8, Frankfort
"Zeitschrift für Flugtechnik und Motorluftschiffahrt"	Bulowstrasse 73, Berlin

ITALIAN

"Revista della Lega Aera Nazionale" (monthly)	Milano
"Revista del Touring Club Italiano" (monthly)	14 v. Monte Napoleone, Milano
"La Navigazione Aerea" (monthly)	Milano

JAPANESE

"Aeronautical World"	Tokyo
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MEXICAN

"Tohtli"	Mexico City (N. Y. office, 29 Beekman St.)
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RUSSIAN

- "Aeronautical Journal of Petrograd" Petrograd
- "Aero" 6 Leitny, Petrograd
- "Dans l'Empire des Airs" (semi-monthly), 7, Rota 25, Petrograd. (Printed in Fr.)
- "Revue de Navigation Aerienne" (weekly) . . . 7 Rue Stremmiannaya, Petrograd

SPANISH

- "Boletin Oficial de la Asociacion de Locomotion Aerea" monthly
- 20 Cataluna Sq., Barcelona
- "Espana Automovil" 5, Isabel 11 Sq., Madrid

SWEDISH

- "Svensk Motor Tidning" (semi-monthly) Fenixpalatest, Stockholm

SPECIFIC GRAVITY EQUIVALENTS FOR DEGREES
BEAUMÉ FOR LIQUIDS LIGHTER
THAN WATER

$$\text{FORMULA: DEGREES BEAUMÉ} = \frac{140}{\text{SP. GR.}_{60^{\circ}\text{F.}}} - 130$$

SP. GR. TAKEN AT 60° F. AND REFERRED TO DISTILLED WATER AT 60° F.

Beaumé	Specific Gravity	Pounds Per Gallon	Beaumé	Specific Gravity	Pounds Per Gallon	Beaumé	Specific Gravity	Pounds Per Gallon
10	1.0000	8.33	37	.8383	6.98	64	.7217	6.01
11	.9929	8.27	38	.8333	6.94	65	.7179	5.98
12	.9859	8.21	39	.8285	6.90	66	.7143	5.95
13	.9790	8.16	40	.8235	6.86	67	.7107	5.92
14	.9722	8.10	41	.8187	6.82	68	.7071	5.89
15	.9655	8.04	42	.8139	6.78	69	.7035	5.86
16	.9589	7.99	43	.8092	6.74	70	.7000	5.83
17	.9524	7.93	44	.8046	6.70	71	.6965	5.80
18	.9459	7.88	45	.8000	6.66	72	.6931	5.78
19	.9396	7.83	46	.7955	6.63	73	.6897	5.75
20	.9333	7.78	47	.7909	6.59	74	.6863	5.72
21	.9272	7.72	48	.7865	6.55	75	.6829	5.69
22	.9211	7.67	49	.7821	6.52	76	.6796	5.66
23	.9150	7.62	50	.7777	6.48	77	.6763	5.63
24	.9091	7.57	51	.7735	6.44	78	.6730	5.60
25	.9032	7.53	52	.7692	6.41	79	.6698	5.58
26	.8974	7.48	53	.7650	6.37	80	.6666	5.55
27	.8917	7.43	54	.7609	6.34	81	.6635	5.52
28	.8861	7.38	55	.7568	6.30	82	.6604	5.50
29	.8805	7.34	56	.7527	6.27	83	.6573	5.48
30	.8750	7.29	57	.7487	6.24	84	.6542	5.45
31	.8696	7.24	58	.7447	6.20	85	.6511	5.42
32	.8642	7.20	59	.7407	6.17	86	.6481	5.40
33	.8589	7.15	60	.7368	6.14	87	.6451	5.38
34	.8537	7.11	61	.7329	6.11	88	.6422	5.36
35	.8485	7.07	62	.7292	6.07	89	.6392	5.33
36	.8433	7.03	63	.7254	6.04	90	.6363	5.30

NOMENCLATURE FOR AERONAUTICS*

AEROFOIL: A thin wing-like structure, flat or curved, designed to obtain reaction upon its surfaces from the air through which it moves.

AEROPLANE: See airplane.

AILERON: A movable auxiliary surface used for the control of rolling motion—*i. e.*, rotation about the fore and aft axis.

AIRCRAFT: Any form of craft designed for the navigation of the air—airplanes, balloons, dirigibles, helicopters, kites, kite-balloons, ornithopters, gliders, etc.

AIRPLANE: A form of aircraft heavier than air which has wing surfaces for sustentation, with stabilizing surfaces, rudders for steering, and power plant for propulsion through the air. The landing gear may be suited for either land or water use.

Pusher.—A type of airplane with the propeller or propellers in rear of the wings.

Tractor.—A type of airplane with the propeller or propellers in front of the wings.

AIR-SPEED METER: An instrument designed to measure the velocity of an aircraft with reference to the air through which it is moving.

ALTIMETER: An instrument mounted on an aircraft to continuously indicate its height above the surface of the earth.

ANEMOMETER: An instrument for measuring the velocity of the wind or air currents with reference to the earth or some fixed body.

ANGLE:

Of attack.—The angle between the direction of the relative wind and the chord of an aerofoil, or the fore and aft axis of a body.

Critical.—The angle of attack at which the lift is a maximum.

Gliding.—The angle the flight path makes with the horizontal when flying in still air under the influence of gravity alone.

ASPECT RATIO: The ratio of spread to chord of an aerofoil.

AXES OF AN AIRCRAFT: Three fixed lines of reference; usually centroidal and mutually rectangular.

The principal longitudinal axis in the plane of symmetry, usually parallel to the axis of the propeller, is called the fore and aft axis (or longitudinal axis); the axis perpendicular to this in the plane of symmetry is called the vertical axis; and the third axis, perpendicular to the other two, is called the athwartship axis (or transverse or lateral axis). In mathematical discussions the first of these axes is called the X axis, the second the Z axis, and the third the Y axis.

BALLONET: A small balloon within the interior of a balloon or dirigible for the purpose of controlling the ascent or descent, and for maintaining pressure on the outer envelope to prevent deformation. The ballonnet is kept inflated with air at the required pressure, under the control of a blower and valves.

BALLOON: A form of aircraft comprising a gas bag and a car, whose sustentation depends on the buoyancy of the contained gas, which is lighter than air.

Captive.—A balloon restrained from free flight by means of a cable attaching it to the earth.

Kite.—An elongated form of captive balloon, fitted with tail appendages to keep it headed into the wind, and deriving increased lift due to its axis being inclined to the wind.

*Compiled from Report No. 9 of National Advisory Committee for Aeronautics.

BANK: To incline an airplane laterally—*i. e.*, to rotate it about the fore and aft axis. Right bank is to incline the airplane with the right wing down.

BANKING SCUDDER: See Aileron.

BAROGRAPH: An instrument used to record variations in barometric pressure. In aeronautics the charts on which the records are made are prepared to indicate altitudes directly instead of barometric pressure.

BIPLANE: A form of airplane in which the main supporting surface is divided into two parts, one above the other.

BODY OF AN AIRPLANE: A structure, usually inclosed, which contains in a stream line housing the power plant, fuel, passengers, etc.

CABRE: A flying attitude in which the angle of attacks is greater than normal; tail down; down by the stern—tail low.

CAMBER: The convexity or rise of a curve of an aerofoil from its chord, usually expressed as the ratio of the maximum departure of the curve from the chord as a fraction thereof. "Top Camber" refers to the top surface of an aerofoil and "Bottom Camber" to the bottom surface; "Mean Camber" is the mean of these two.

CAPACITY:

Lifting.—The maximum flying load of an aircraft.

Carrying.—Excess of the lifting capacity over the dead load of an aircraft, which latter includes structure, power plant, and essential accessories.

CARRYING CAPACITY: See Capacity.

CENTER: The point in which a set of effects is assumed to be accumulated producing the same effect as if all were concentrated at this point.

Of buoyancy.—The center of gravity of the fluid displaced by the floating body.

Of pressure of an aerofoil.—The point on the chord of an element of an aerofoil, prolonged if necessary, through which at any instant the line of action of the resultant air force passes.

Of pressure of a body.—The point on the axis of a body, prolonged if necessary, through which at any instant the line of action of the resultant air force passes.

CHORD:

Of an aerofoil section.—A right line tangent to the under curve of the aerofoil section at the front and rear.

Length.—The length of the chord is the length of the aerofoil section projected on the chord, extended if necessary.

CONTROLS: A general term applying to the means provided for operating the devices used to control speed, direction of flight, and attitude of an aircraft.

CRITICAL ANGLE: See Angle, Critical.

DECALAGE: An increase in the angular setting of the chord of an upper wing of a biplane with reference to the chord of the lower wing.

DEVELOPED AREA OF A PROPELLER: A layout of the area of a propeller blade designed to represent the total area of the driving face, in which the elements of area are developed as if unfolded onto the plane of the drawing (necessarily an approximation on definite assumptions, as no true development of the helix can be made).

DIRIGIBLE: A form of balloon, the outer envelope of which is of elongated form, provided with a propelling system, car, rudders, and stabilizing surfaces.

Nonrigid.—A dirigible whose form is maintained by the pressure of the contained gas assisted by the car-suspension system.

Rigid.—A dirigible whose form is maintained by a rigid structure contained within the envelope.

Semirigid.—A dirigible whose form is maintained by means of its attachment to an exterior girder construction containing the car.

DISK AREA OF A PROPELLER: The total area of the disk swept by the propeller tips.

DIVING RUDDER: See elevator.

DOPE: A general term applied to the material used in treating the cloth surface of airplane members to increase strength, produce tautness, and act as a filler to maintain air-tightness; usually of the cellulose type.

DRAG: The total resistance to motion through the air of an air craft—*i. e.*, the sum of the drift and head resistance.

DRIFT: The component of the resultant wind pressure on an aerofoil or wing surface parallel to the air stream attacking the surface.

ELEVATOR: A hinged surface for controlling the longitudinal attitude of an air craft—*i. e.*, its rotation about the athwartship axis.

ENGINE, RIGHT OR LEFT HAND: The distinction between a right-hand and a left-hand engine depends on the rotation of the output shaft, whether this shaft rotates in the same direction as the crank or not. A right-hand engine is one in which, when viewed from the output shaft end, the shaft is seen to rotate anticlockwise.

ENTERING EDGE: The foremost part of an aerofoil.

FINS: Small planes on air craft to promote stability; for example, vertical tail fins, horizontal tail fins, skid fins, etc.

FLIGHT PATH: The path of the center of gravity of an air craft with reference to the air.

FLOAT: That portion of the landing gear of an air craft which provides buoyancy when it is resting on the surface of the water.

FUSELAGE: See body.

GAP: The distance between the projections on the vertical axis of the entering edges of an upper and lower wing of a biplane.

GLIDE: To fly without power.

GLIDER: A form of air craft similar to an airplane, but without any power plant. When utilized in variable winds it makes use of the soaring principles of flight and is sometimes called a soaring machine.

GLIDING ANGLE: See Angle, Gliding.

GUY: A rope, chain, wire, or rod attached to an object to guide or steady it, such as guys to wing, tail, or landing gear.

HEAD RESISTANCE: The total resistance to motion through the air of all parts of an air craft not a part of the main lifting surface. Sometimes termed "parasite resistance."

HELICOPTER: A form of air craft whose support in the air is derived from the vertical thrust of large propellers.

INCLINOMETER: An instrument for measuring the angle made by any axis of an air craft with the horizontal.

- KEEL PLANE AREA:** The total effective area of an air craft which acts to prevent skidding or side slipping.
- KITE:** A form of air craft without other propelling means than the towline pull, whose support is derived from the force of the wind moving past its surface.
- KITE BALLOON:** See Balloon, kite.
- LANDING GEAR:** The under structure of an air craft designed to carry the load when resting on, or running on, the surface of the land or water.
- LATERAL STABILITY:** See Stability, lateral.
- LEADING EDGE:** See Entering edge.
- LEEWAY:** The angular deviation from a course over the earth, due to cross currents of wind.
- LIFT:** The component of the force due to the air pressure of an aerofoil, resolved perpendicular to the flight path in a vertical plane.
- LIFT BRACING:** See Stay.
- LIFTING CAPACITY:** See Capacity, lifting.
- LOAD, FULL:** See Capacity, lifting.
Reserve (or useful).—See Capacity, carrying.
- LOADING:** See Wing loading.
- LONGITUDINAL:** A fore-and-aft member of the framing of an airplane body, or of the floats, usually continuous across a number of points of support.
- LONGITUDINAL STABILITY:** See Stability.
- METACENTER:** The point of intersection of a vertical line through the center of gravity of the fluid displaced by a floating body when it is tipped through a small angle from its position of equilibrium and the inclined line which was vertical through the center of gravity of the body when in equilibrium. There is, in general, a different metacenter for each type of displacement of the floating body.
- MONOPLANE:** A form of airplane whose main supporting surface is disposed as a single wing on each side of the body.
- MOTOR:** See Engine.
- NACELLE:** See Body.
- NATURAL STABILITY:** See Stability.
- NOSE DIVE:** A dangerously steep descent, head-on.
- ORNITHOPTER:** A form of aircraft deriving its support and propelling force from flapping wings.
- PITOT TUBE:** A tube with an end open square to the fluid stream, used as a detector of an impact pressure. More usually associated with a concentric tube surrounding it, having perforations normal to the axis for indicating static pressure. The velocity of the fluid can be determined from the difference between the impact pressure and the static pressure. This instrument is often used to determine the velocity of an aircraft through the air.
- PROPELLER:**
Developed area of.—See Developed area of a propeller.
Disk area of.—See Disk area of a propeller.
Right-hand.—One in which the helix is right handed.
- PUSHER:** See Airplane.
- PYLON:** A marker of a course.
- RACE OF A PROPELLER:** The air stream delivered by the propeller.
- RIB:** See Wing.

RIGHT (OR LEFT) HAND:

Engine.—See Engine.

Propeller.—See Propeller, right-hand.

RIGID DIRIGIBLE: See Dirigible, rigid.

RUDDER: A hinged or pivoted surface, usually more or less flat or stream lines, used for the purpose of controlling the attitude of an aircraft about its vertical axis when in motion.

SIDE SLIPPING: Sliding toward the center of a turn. It is due to excessive amount of bank for the turn being made, and is the opposite of skidding.

SKIDDING: Sliding sideways in flight away from the center of the turn. It is usually caused by insufficient banking in a turn, and is the opposite of side slipping.

SKIDS: Long wooden or metal runners designed to prevent nosing of a land machine when landing or to prevent dropping into holes or ditches in rough ground. Generally designed to function should the wheels collapse or fail to act.

SLIP: This term applies to propeller action and is the difference between the actual velocity of advance of an aircraft and the speed calculated from the known pitch of the propeller and its number of revolutions.

SOARING MACHINE: See Glider.

SPREAD: The maximum distance laterally from tip to tip of an airplane wing.

STABILITY: The quality of an aircraft in flight which causes it to return to a condition of equilibrium when meeting a disturbance. (This is sometimes called "Dynamical stability.")

Directional.—Stability with reference to the vertical axis.

Inherent.—Stability of an aircraft due to the disposition and arrangement of its fixed parts.

Lateral.—Stability with reference to the longitudinal (or fore and aft) axis.

Longitudinal.—Stability with reference to the lateral (or athwartship) axis.

STABILIZER: See Fins.

Mechanical.—Any automatic device designed to secure stability in flight.

STAGGER: The amount of advance of the entering edge of the upper wing of a biplane over that of the lower; it is considered positive when the upper surface is forward.

STALLING: A term describing the condition of an airplane which from any cause has lost the relative speed necessary for steerageway and control.

STATOSCOPE: An instrument to detect the existence of a small rate of ascent or descent, principally used in ballooning.

STAY: A wire, rope, or the like, used as a tie piece to hold parts together, or to contribute stiffness; for example, the stays of the wing and body trussing.

STEP: A break in the form of the bottom of a float.

STREAM-LINE FLOW: A term in hydromechanics to describe the condition of continuous flow of a fluid, as distinguished from eddying flow where discontinuity takes place.

STREAM-LINE SHAPE: A shape intended to avoid eddying or discontinuity and to preserve stream-line flow, thus keeping resistance to progress at a minimum.

STRUT: A compression member of a truss frame; for instance, the vertical members of the wing truss of a biplane.

- SWEEP BACK:** The horizontal angle between the lateral (athwartship) axis of an airplane and the entering edge of the main planes.
- TAIL:** The rear portion of an aircraft, to which are usually attached rudders, elevators, and fins.
- TAIL FINNS:** The vertical and horizontal surfaces attached to the tail, used for stabilizing.
- THRUST DEDUCTION:** Due to the influence of the propellers, there is a reduction of pressure under the stern of the vessel which appreciably reduces the total propulsive effect of the propeller. This reduction is termed "Thrust deduction."
- TRACTOR:** See Airplane.
- TRAILING EDGE:** The rearmost portion of an aerofoil.
- TRIPLANE:** A form of airplane whose main supporting surfaces are divided into three parts, superposed.
- TRUSS:** The framing by which the wing loads are transmitted to the body; comprises struts, stays, and spars.
- VELOMETER:** See Air-speed meter and anemometer.
- VOL-PIQUE:** See Nose dive.
- VOL-PLANE:** See Glide.
- WAKE GAIN:** Due to the influence of skin friction, eddying, etc., a vessel in moving forward produces a certain forward movement of the fluid surrounding it. The effect of this is to reduce the effective resistance of the hull, and this effect, due to the forward movement of the wake, is termed the "wake gain."
In addition to this effect the forward movement of this body of fluid reduces the actual advance of the propeller through the surrounding medium, thereby reducing the propeller horsepower.
- WARP:** To change the form of the wing by twisting it, usually by changing the inclination of the rear spar relative to the front spar.
- WINGS:** The main supporting surfaces of an airplane.
- WING LOADING:** The weight carried per unit area of supporting surface.
- WING RIB:** A fore and aft member of the wing structure used to support the covering and to give the wing section its form.
- WING SPAR:** An athwartship member of the wing structure resisting tension and compression.
- YAW:** To swing off the course about the vertical axis, owing to gusts or lack of directional stability.
Angle of.—The temporary angular deviation of the fore and aft axis from the course.

METRIC CONVERSION TABLE

ENGLISH TO METRIC

English Units	Hundredths of an Inch to M/M	Feet to Meters	Miles to Kilometers	Gallons to Liters	Pounds to Kilometers
1	0.254	0.30480	1.6093	3.7853	0.45359
2	0.508	.60960	3.2187	7.5707	.90718
3	0.762	.91440	4.8280	11.3560	1.36078
4	1.016	1.21920	6.4374	15.1413	1.81437
5	1.270	1.52400	8.0467	18.9267	2.26796
6	1.524	1.82880	9.6561	22.7120	2.72155
7	1.778	2.13360	11.2654	26.4973	3.17515
8	2.032	2.43840	12.8748	30.2827	3.62874
9	2.286	2.74321	14.4841	34.0680	4.08233
10	2.540	3.04801	16.0935	37.8533	4.53592
11	2.794	3.35281	17.7028	41.6387	4.98552
12	3.048	3.65761	19.3122	45.4240	5.44311
13	3.302	3.96241	20.9215	49.2093	5.89670
14	3.556	4.26721	22.5309	52.9947	6.35029
15	3.810	4.57201	24.1402	56.7800	6.80389
16	4.064	4.87681	25.7496	60.5653	7.25748
17	4.318	5.18161	27.3589	64.3506	7.71107
18	4.572	5.48641	28.9682	68.1360	8.16466
19	4.826	5.79121	30.5776	71.9213	8.61826
20	5.080	6.09601	32.1869	75.7066	9.07185
21	5.334	6.40081	33.7963	79.4920	9.52544
22	5.588	6.70561	35.4056	83.2773	9.97903
23	5.842	7.01041	37.0150	87.0626	10.43263
24	6.096	7.31521	38.6243	90.8480	10.88622
25	6.350	7.62002	40.2337	94.6333	11.33981
26	6.604	7.92482	41.8430	98.4186	11.79340
27	6.858	8.22962	43.4524	102.2040	12.24700
28	7.112	8.53442	45.0617	105.9893	12.70059
29	7.366	8.83922	46.6711	109.7746	13.15418
30	7.620	9.14402	48.2804	113.5600	13.60777
31	7.874	9.44882	49.8898	117.3453	14.06137
32	8.128	9.75362	51.4991	121.1306	14.51496
33	8.382	10.05842	53.1085	124.9160	14.96855
34	8.636	10.36322	54.7178	128.7013	15.42214
35	8.890	10.66802	56.3272	132.4866	15.87573
36	9.144	10.97282	57.9365	136.2720	16.32933
37	9.398	11.27762	59.5458	140.0573	16.78292
38	9.652	11.58242	61.1552	143.8426	17.23651
39	9.906	11.88722	62.7645	147.6280	17.69010
40	10.160	12.19202	64.3739	151.4133	18.14370
41	10.414	12.49682	65.9832	155.1986	18.59729
42	10.668	12.80163	67.5926	158.9840	19.05088
43	10.922	13.10643	69.2019	162.7693	19.50447
44	11.176	13.41123	70.8113	166.5546	19.95807
45	11.420	13.71603	72.4206	170.3400	20.41166
46	11.684	14.02083	74.0300	174.1253	20.86525
47	11.938	14.32563	75.6393	177.9106	21.31880
48	12.192	14.63043	77.2487	181.6960	21.77244
49	12.446	14.93523	78.8580	185.4813	22.22603
50	12.700	15.24003	80.4674	189.2666	22.67962
100	25.400	30.48006	160.9347	378.5330	45.35924

METRIC CONVERSION TABLE

METRIC TO ENGLISH

Metric Units	M/M to Inches	Meters to Feet	Kilometers to Miles	Liters to Gallons	Kilograms to Pounds
1	0.03937	3.28083	0.62137	0.26418	2.2046
2	.07874	6.56167	1.24274	0.52836	4.4092
3	.11811	9.84250	1.86411	0.79253	6.6139
4	.15748	13.12333	2.48548	1.05671	8.8185
5	.19685	16.40417	3.10685	1.32089	11.0231
6	.23622	19.68500	3.72822	1.58507	13.2277
7	.27559	22.96583	4.34959	1.84924	15.4324
8	.31496	26.24667	4.97096	2.11342	17.6370
9	.35433	29.52750	5.59233	2.37760	19.8416
10	.39370	32.80833	6.21370	2.64178	22.0462
11	.43307	36.08917	6.83507	2.90595	24.2508
12	.47244	39.37000	7.45644	3.17013	26.4555
13	.51181	42.65083	8.07781	3.43431	28.6601
14	.55118	45.93167	8.69918	3.69849	30.8647
15	.59055	49.21250	9.32055	3.96266	33.0693
16	.62992	52.49333	9.94192	4.22684	35.2740
17	.66929	55.77417	10.56329	4.49102	37.4786
18	.70866	59.05500	11.18466	4.75520	39.6832
19	.74802	62.33583	11.80603	5.01937	41.8878
20	.78740	65.61667	12.42740	5.28355	44.0924
21	.82677	68.89750	13.04877	5.54773	46.2971
22	.86614	72.17833	13.67014	5.81191	48.5017
23	.90551	75.45917	14.29151	6.07608	50.7063
24	.94488	78.74000	14.91288	6.34026	52.9109
25	.98425	82.02083	15.53425	6.60444	55.1156
26	1.02362	85.30167	16.15562	6.86862	57.3202
27	1.06299	88.58250	16.77699	7.13280	59.5248
28	1.10236	91.86333	17.39836	7.39697	61.7294
29	1.14173	95.14417	18.01973	7.66115	63.9340
30	1.18110	98.42500	18.64110	7.92533	66.1387
31	1.22047	101.70583	19.26247	8.18951	68.3433
32	1.25984	104.98667	19.88384	8.45368	70.5479
33	1.29921	108.26750	20.50521	8.71786	72.7525
34	1.33858	111.54833	21.12658	8.98204	74.9572
35	1.37795	114.82917	21.74795	9.24622	77.1618
36	1.41732	118.11000	22.36932	9.51039	79.3664
37	1.45669	121.39083	22.99069	9.77457	81.5710
38	1.49606	124.67167	23.61206	10.03875	83.7756
39	1.53543	127.95250	24.23343	10.30293	85.9803
40	1.57480	131.23333	24.85480	10.56710	88.1849
41	1.61417	134.51417	25.47617	10.83128	90.3895
42	1.65354	137.79500	26.09754	11.09546	92.5941
43	1.69291	141.07583	26.71891	11.35964	94.7988
44	1.73228	144.35667	27.34028	11.62381	97.0034
45	1.77165	147.63750	27.96165	11.88799	99.2080
46	1.81102	150.91833	28.58302	12.15217	101.4126
47	1.85039	154.19917	29.20439	12.41635	103.6173
48	1.88976	157.48000	29.82576	12.68052	105.8219
49	1.92913	160.76083	30.44713	12.94470	108.0265
50	1.96850	164.04167	31.06850	13.20888	110.2311
100	3.93700	328.08334	62.13700	26.41776	220.4622

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